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Supplies That Cost Nothing?

"We are not interested in fuel economy; you know our coal does not cost anything. The company owns the mines." How well this statement, recently made by a railroad officer, represents the state of mind that exists with many officers and a large number of employees in regard to the value of railway supplies. The machinist thinks, "It makes no difference if I ruin this reamer or milling cutter, they are made here in the tool room and do not cost the road anything." The car repair man says, "Why should I bother to pick up those good bolts, our bolt department turns out thousands of them every day." The fireman cares nothing about overloading the tender and putting a half ton of coal on the ground; the coal chute men are there anyway and it will not cost anything to the railroad for picking it up. And so it goes on. A coal shovel, a pint of valve oil, a monkey wrench or a jack are valuable and must be taken care of, but a steel bar pounding an ash pan until it leaks, or the burning up of a long 1½ in. drill is of no importance, as they are made at the shops and do not cost anything (?).

Improving Valve Gears

In an attempt to correct an undoubted, but generally believed to be a minor fault of the ordinary types of locomotive valve gears, which results from the change in the relative positions of the main driving axle and the cylinders, a designer on the Chicago, Peoria & St. Louis has very materially increased a much more serious difficulty by practically doubling the weight of the gear. This design is illustrated and described in this issue, and it will be seen that in the effort to obtain a rigidly supported source of motion for an ordinary Walschaert gear, a number of very heavy parts have been added. The advisability of attempting any great refinement in the steam distribution of a locomotive is doubtful, especially where the ordinary reverse lever is employed. The conditions of operation are so constantly varying that in order to obtain the benefit of a thoroughly accurate valve gear giving an ideal steam distribution, it is necessary to make frequent small adjustments in the location of the point of cut-off. The full advantage of a refinement of this kind is entirely impossible with a reverse lever, and it is doubtful if it would actually be made even with a screw reverse gear. The experience of valve gear manufacturers and designers of locomotives has always led to the same conclusion, *i. e.*, extreme accuracy in valve events or in steam distribution is not possible or even advisable. The successful valve gears have been those which presented a simplicity of arrangement, a low cost of maintenance and ease of inspection. On the other hand, a reduction in the weight of a valve gear is of decided importance. It is quite probable that when the design throughout is refined as it will be in the future, and advantage is taken of the high quality materials that are available, even the present valve gears will seem large and cumbersome. Any effort toward increasing the weight of the valve gear without an undoubted corresponding advantage is a move in the wrong direction.

Work of the Firemen

At one of the sessions of the Arbitration Board which is hearing arguments in connection with the demand of the locomotive firemen for increased wages, D. F. Crawford, general superintendent of motive power of the Pennsylvania Lines West, presented some interesting statistics based on actual observation of the amount of time spent by a fireman in manual labor. These observations covered a large number of trips, including both stoker and non-stoker locomotives running on various divisions of the Pennsylvania Railroad. The average for non-stoker locomotives weighing over 200,000 lbs. shows that the fireman is actually engaged in supplying coal to the firebox about 15 per cent. of the total time of the trip. He is shaking the grates, hooking the fire or shoveling down coal about 5 per

cent. of the time (this feature varies considerable on different runs), is engaged in other manual labor about 6 per cent. of the time and is idle, so far as performing manual labor is concerned, about 71 per cent of the time. On a stoker locomotive weighing over 200,000 lbs. he is engaged in supplying coal to the firebox with a shovel about 2 per cent. of the time, shaking grates, hooking fire, etc., about 5 per cent. of the time, performing other manual labor about 2 per cent., and is idle about 91 per cent. of the time. At the same time Mr. Crawford presented some statistics in connection with the increase in weight, tractive effort and coal consumption of locomotives. This was based on information from 40 railways. It shows that during the past three years the tractive effort has increased on an average of less than 7 per cent., the weight on drivers slightly over 7 per cent. and the coal consumed per locomotive mile 3.2 per cent. The wages of the firemen have increased 6 per cent. in the same length of time. For a twelve-year period from 1900 to 1912 these statistics show that on freight locomotives, the tractive effort has increased on an average of 52 per cent., the weight on drivers 46½ per cent., pounds of coal consumed per locomotive mile 47 per cent., while the wages have increased 59 per cent.

Car Department Competition

Eight papers were submitted in the car department competition which closed February 15. These were set in type, so that the judges might not be prejudiced in any way against those which were sent in in longhand and were not as easy to read as if typewritten, and were forwarded to nine judges, including five car department officers and four mechanical engineers who are noted because of the car designs which they have developed. The papers were numbered and each judge was requested to advise which number, in his opinion, should receive first prize, and which the second. The first prize of $50 was awarded to F. F. Gaines, superintendent of motive power of the Central of Georgia, for his article on "The Growing Cost of Freight Car Maintenance and the Remedy," which appears elsewhere in this issue. The second prize was awarded to L. W. Wallace, assistant professor of car and locomotive design at Purdue University, for an article describing the method of designing a steel gondola car. An article by R. W. Schulze, general foreman car department of the Gulf, Colorado & Santa Fe at Cleburne, Tex., pushed Prof. Wallace's article hard for the second place. All of the articles possess merit and all have been accepted for publication, and checks are being mailed to the authors. The other competitors, with the titles of their papers, are as follows: C. L. Alden, foreman car repairs, New York Central & Hudson River, West Albany, N. Y., on Freight Car Troubles; Frank J. Borer, department foreman, Central of New Jersey, Elizabethport, N. J., on Defective Applications of Brake Apparatus; C. L. Bundy, general foreman, Delaware, Lackawanna & Western, Kingsland, N. J., on Freight Car Design; H. S. Fentress, foreman car department, Norfolk Southern, Berkley, Va., on Box Car Construction as Viewed by a Repairer; and H. E. Parsons, Berwick, Pa., on Tank Car Design.

The judges were F. W. Brazier, superintendent rolling stock of the New York Central & Hudson River; J. M. Borrowdale, superintendent car department of the Illinois Central; R. W. Burnett, general master car builder of the Canadian Pacific; J. C. Fritts, master car builder of the Delaware, Lackawanna & Western; J. H. Gimpel, general foreman car department of the Frisco Lines; W. F. Keisel, Jr., assistant mechanical engineer of the Pennsylvania; John A. Pilcher, mechanical engineer of the Norfolk & Western; W. P. Richardson, mechanical engineer of the Pittsburgh & Lake Erie; and C. A. Seley, mechanical engineer of the Rock Island Lines.

Six of the judges awarded the first prize to Mr. Gaines, one to Mr. Wallace, one to Mr. Alden, and one to Mr. Bundy. In addition to receiving one vote for the first place, Mr. Wallace received four for the second place; Mr. Schulze received three votes for the second place; Messrs. Fentress and Alden each received one vote for the second place.

Decreasing Shop Operating Costs

An excellent example of what may be done economically to reduce the operating costs of old shops is shown in the changes that have been made at the Burnside shops of the Illinois Central, a description of which is given in another part of this issue. In this case a number of stationary engines were distributed throughout the plant to provide power for the various shops. These were supplied with steam from a main boiler plant, necessitating long steam lines, and also required high class labor for their operation. In cold weather it was found impossible to meet the steam demands with the boiler equipment at hand, and as a result several locomotives were pressed into service which provided the steam at a very high cost. By careful study and investigation it was found that it would be cheaper to discontinue the use of the individual engines, have one main engine room for the generation of electricity, and to generally electrify the shops. The results clearly show how money may be saved by bringing a plant up to date. The boiler plant has been rearranged so that a saving of about 50 per cent. in its operating cost has been effected, and by the addition of generators and some 150 to 175 motors the total cost of operation has been reduced, so that it will pay an annual return on the money invested to make these changes.

In many cases the very word "electrify" carries with it the feeling of additional costs for seemingly luxurious means of shop operation, but it has been proved in cases of this kind that the added expenditure is money well invested. This phase of shop operation should be carefully considered where unsatisfactory results are being obtained in the shop operation, for if carefully considered, and as carefully applied, there would be no more remunerative returns than this class of betterment work. There is no other method of power so susceptible of being expanded as the electrified shop, and there certainly is no more convenient service, especially where both the alternating and direct current are available. It is generally acknowledged that these two classes of power are quite essential, and in many cases where one only is directly provided it has been found expedient to install a motor generator set to provide the other.

The installation of low pressure turbines to use the exhaust steam from the main engines was adopted after a careful study of the possibilities of the economy in heating the plant with exhaust steam as against low pressure steam. The work is a credit to the mechanical department of the Illinois Central and bespeaks the value of maintaining a sub-department under the control of a competent shop engineer who devotes his whole time to the important problem of shop operation.

Locomotive Connecting Rods

The breaking of a locomotive main or side rod is an infrequent occurrence, but when it does occur the accident usually happens when the locomotive is in motion and most generally at high speeds. The fact that there are not more accidents of this kind speaks well for the ability of the designers, particularly those of the locomotive builders, for it is there that most of the rods are designed. A committee of the Master Mechanics' Association presented an excellent and quite complete report on the subject of main and side rods at the 1911 and 1912 conventions, which included a number of formulas, among them being those used at the Baldwin Locomotive Works, In this issue H. A. F. Campbell, who is largely responsible for the development of the standards of the Baldwin Locomotive Works in this particular, presents a complete explanation and discussion of these formulas and includes many tables, some of which give results of experiments that have not been heretofore published, while others are constants and ratios that will be found very convenient.

When rods do break it is very frequently found that the fault lies not with the design but with the material. Most American railways use open hearth steel having an ultimate tensile strength of 80,000 lbs. per sq. in. and the maximum working stress allowed should not be greater than 10,000 lbs. per sq. in. It has been found that even under the most rigid inspection, flaws in the steel will sometimes remain undetected and the rod will eventually break although the design was correct in every particular. This is especially true with I-section rods which are milled from a solid bar. In some cases return has been made to the rectangular section because of this difficulty while in others the rod is being forged to the I-section. Alloy steels, particularly those containing vanadium, are now also being used to some extent. It is evident that even after the rod is designed and has a size and shape that is properly suited for the conditions, its strength is by no means assured and the kind of material, methods of manufacture and ability of the inspectors need an equal or greater attention.

The question is frequently asked, "Why are main and side rods on European locomotives so much lighter than those on American locomotives?" Mr. Campbell presents data which shows that they actually are not lighter when the amount of work as performed by each rod is considered. Many of the European locomotives are of the four cylinder type and most of them have very short rods. This, taken in connection with the cross section selected by most of the foreign designers, makes the rods look decidedly lighter, but actually they are not, when compared on the basis of pounds of load carried to each pound of rod.

Another Locomotive Testing Plant

It would be impossible to estimate the value of the results to the railroads of the world, that have come from the locomotive testing plants at Purdue University, the St. Louis World's Fair and at Altoona. A scientific investigation of many features of design or operation of a locomotive is largely dependent upon results of tests that can be made only on a testing plant. Road tests are of great importance and give results which cannot be obtained by a testing plant, but, on the other hand, the testing plant furnishes data that cannot be reliably procured from any kind of a road test. It is only on the testing plant that all the conditions can be controlled so as to obtain reliable information on the effect of varying a single condition. The value of testing plant work is particularly evident in connection with the investigation of all questions relating to boiler and firebox performance and the action of steam in the cylinders.

A new and much larger locomotive testing plant will be put in operation at the University of Illinois during the current month. Its general arrangement and prominent features were described by Prof. E. C. Schmidt in a paper presented at the March meeting of the Western Railway Club. This plant will be decidedly larger than any in existence and is arranged to permit the testing of articulated locomotives of the largest size. The dynamometer will permit measuring draw-bar pulls up to 125,000 lbs., and the bed plate of the plant is of sufficient length to allow the installing of the largest locomotive now in use. It thus appears that it will soon be possible to obtain reliable information on some of the problems peculiar to the articulated type of locomotive of large size, concerning which there is now considerable doubt. In a general way the new testing plant is very similar to the one owned by the Pennsylvania Railroad and the one at Purdue University. The carrying wheels and their supports have the same general arrangement and provision has been made for the use of two diameters of supporting wheels, a feature of considerable importance for a plant that is expected to make tests at both high and low speeds. The Alden friction brake used on all of these plants for absorbing the power does not operate satisfactorily at very low speeds, while on the other hand difficulty may be incurred with the bearings and with the control of the water pressure on the brakes at very high speeds. In the new plant supporting wheels either 52 in. or 72 in. in diameter may be used. At a speed of the locomotive drivers corresponding to 10 miles an hour the smaller wheels will have a speed of about 65 revolutions a minute. The larger wheels will have a speed of about 420 revolutions a minute at a locomotive speed corresponding to 90 miles an hour.

The dynamometer is of the same general type, but of much larger capacity than the one at Purdue, and employs the graphical recording of the pressure of oil in a closed chamber for obtaining the record of the draw-bar pull. This differs from the Pennsylvania dynamometer, which does not employ a liquid medium, but is arranged to give a pen movement of 8 in. from the maximum draw-bar movement of .04 in. by a system of levers and the torsion of a steel rod. It has a maximum capacity of 80,000 lbs. pull.

There has never been an entirely satisfactory method evolved for procuring accurate information as to the amount of fuel lost through the locomotive stack in the form of sparks and cinders. At Altoona various plans and arrangements have been tried, resulting finally in the building of an inclosed superstructure on top of the testing plant inclosure and providing vents for the gradual escape of smoke and gases at such points that there would be no direct draft to carry away the lighter cinders. This method, while it gave fairly accurate returns, has not been altogether satisfactory. Arrangements for collecting the cinders and gases from a certain known proportion of the stack area by means of an apparatus which could be swung to different positions on top of the stack has also been employed by Dr. Goss, but was not considered suitable for the testing plant. Therefore in the new plant a new and somewhat elaborate arrangement has been installed for collecting the solid matter in the exhaust. In view of the fact that the testing plant is located in close proximity to other university buildings at Urbana, it was desirable to have a stack of sufficient height to prevent the fumes from being offensive to the immediate neighborhood, and for this purpose it was determined to have it at least 80 ft. high. This requirement offered a solution for the spark collecting problem, and the plant as built has a separator at the base of a brick stack 8 ft. in diameter and 81 ft. high located at the rear of the laboratory. The steam and gases as discharged from the locomotive pass through a steel elbow which carries them up and over to the center of the building, where they are received in a horizontal duct of large size running through the center of the roof trusses. A suction fan at the end of this duct in the rear of the building draws the gases through it and discharges them through another flue to the separator in the base of the stack. This separator requires the incoming gases to assume a circular movement and to pass downward around an internal sleeve and then upward through the sleeve to the top of the stack. It is probable that most of the heavier cinders will be deposited in the horizontal duct, and traps are provided for removing them. The lighter ones passing through the fan will be thrown outward against the walls of the separating chamber by the circular movement of the gas stream and will fall to the hopper at the bottom, where they may be drawn off and weighed. The fan has a runner 6 ft. in diameter, and at maximum speed will pass 140,000 cu. ft. of gas a minute. The elbow from the horizontal duct to the locomotive stack is of steel, and it is expected that it will need frequent renewal. The other parts of the system, with the exception of the fan, are made of an asbestos board which will resist corrosion. A reinforced concrete reservoir of 100,000 gal. capacity will be built, and the water for the brakes will be drawn from this and returned to it so that none of it will be wasted with the exception of that used for feed water for the locomotive. It is not the plan of the University to own a locomotive for use on this testing plant. The facilities will be available for use in testing new designs or arrangements, and it is expected that the railways and locomotive builders will furnish the locomotives to be tested.

NEW BOOKS

Worm Gearing. By Hugh Kerr Thomas. Bound in cloth, 86 pages, 6 in. x 9 in. Illustrated. Published by the McGraw-Hill Book Co., 239 West 39 street, New York. Price $1.50.

The literature on the subject of worm gearing is extremely meager, and it is believed that in this book, for the first time, this comparatively little understood branch of applied mechanics is exhaustively treated. A complete analysis of the principles of design is given, and throughout the subject is handled in an analytical and practical manner, diagrams, curves and formula being extensively used. The application of worm gearing as a differential driving gear on automobiles and for reduction gears in connection with steam turbines on ships is given special attention.

Characteristics and Limitations of the Series Transformer. By H. R. Woodrow and A. R. Anderson. Bulletin No. 61 from the Engineering Experiment Station, Urbana, Ill. Bound in paper. Illustrated, 45 pages, 6 in. x 9 in. Published by the University of Illinois, W. F. M. Goss, Director of the Engineering Experiment Station, Urbana, Ill. Copies free.

In determining the action of electric circuits of high voltage, or of heavy current, it is often desirable to connect instruments in a circuit which is arranged to carry a current bearing a known ratio to the current of the main circuit. These conditions are made by the use of a series or "current" transformer and this bulletin presents the results of a theoretical study of such transformers, and sets forth the conditions affecting the ratio of secondary to primary current and the phase angle between them. It demonstrates the inadequacy of the series transformer, especially when constructed with an iron core, for the recording of transient phenomena.

Practical Locomotive Operating. By Clarence Roberts, Assistant Road Foreman of Engines, Pennsylvania Railroad, and Russell M. Smith, Air Brake Instructor, Pennsylvania Railroad. Bound in cloth, 292 pages, 6 in. x 8¼ in. 92 illustrations and 5 inserts. Published by J. B. Lippincott Company, Philadelphia, Pa. Price $2.

This book is intended for the use of locomotive engineers and firemen, its specialty being the running, firing and care of locomotives in service. No attempt has been made to go into the questions of design and shop repairs, and where formulas are used they are given as briefly as possible, without any involved mathematics. No attempt has been made to describe the air brake system or its operation, the authors leaving that subject to those books which are devoted entirely to it, and no description of appliances which are in experimental use only, is included in the book.

Part one deals with horse power, tractive effort, train resistance and locomotive efficiency. Part two takes up the systems of locomotive classification most in use and gives illustrations of prevailing types, with tables of dimensions and characteristics. Part three is devoted to useful notes and tables, and deals briefly with such subjects as physics, mechanics and chemistry. Part four considers steam and its properties, saturated and superheated. Part five deals with boilers and related devices while part six covers the subject of lubrication. Part seven takes up cylinders, valves and valve gears. Part eight deals with the running and firing of locomotives, part nine with disorders and breakdowns, and part ten with parts and appliances, such as injectors, lubricators, etc. Part eleven is devoted to qualifications and responsibilities and deals with operating conditions, selection of engineers and firemen, etc., and concludes with a series of questions on the locomotive. Part twelve gives a summary of the federal laws pertaining to locomotives. The law pertaining to boilers is dealt with in eight pages, and the more important requirements of the safety appliance law are given. The book is well printed and the illustrations clear.

COMMUNICATIONS

HANDLING SAND ON LOCOMOTIVES

Yeadon, Pa., December 27, 1912.

To the Editor of the American Engineer:

In traveling over some of the leading railway lines of the East, the writer has been somewhat unfavorably impressed with the evident lack of proper care on the part of those whose duty it is to supply sand to the sandboxes of locomotives. In numerous instances quantities of sand which had been spilled in filling were allowed to remain on top of the boiler casing and on the running boards, from which points the vibration of the engine naturally caused it to silt downwards into the guides, valve gears, and beyond a doubt even into the axle boxes, especially those of the forward drivers and the truck; while the winds of nature, uniting with those caused by the swift motion of the engine itself, blew portions of it into the mechanism of passing engines.

It might be pertinent to ask whether even a very small portion of sand so out of place does not frequently cause unnecessary cutting of machinery and consequent earlier call for repair than would be the case from the unavoidable injuries from dust arising from the permanent way or cinders falling from the locomotives; or it might be a question whether the additional time consumed by the laborers in using greater care in filling sand, and the additional time lost by the engines from service while such care was being observed, would amount to more than the cost of repairs resulting from the present practice.

In one or two instances noted, one that of a passenger locomotive, the lids of the sandboxes were also missing, thus affording easy ingress to rain, or to water which might pass out with the exhaust in case a boiler was allowed to become too full, or evidenced a slight tendency to foam: and this entrance of water would of course result in packed sand, with probable delay of trains in consequence.

The position of the sandboxes in English practice has always appealed to me, both from the standpoint of convenience in handling and from the aesthetic, as its absence from the top of the boiler greatly improves the appearance of the engine and also dispenses with one obstacle to the engineman's clear view of the line. With the present large boilers the English position would certainly be an aid to those supplying the boxes with sand in many ways, even though two boxes must necessarily be attended to on each engine.

Of course I know that the position on the top of the boiler is largely favored on the continent of Europe, and one might say exclusively by locomotive builders of the United States, chiefly I believe, because of a claim that the sand becomes moister in the boxes placed under the running boards, and consequently gives trouble from packing, but travel over most of the leading lines of the British Isles has failed to show me trouble on those roads from this cause, hence it may be inferred that when such trouble does arise it is possibly in a great measure owing to quality of sand used and to imperfect drying.

During 1861 the Pennsylvania Railroad Company had six freight locomotives, four passenger and several tank engines, fitted with sandboxes under the running boards and retained them in that position for four or five years; and again in 1881 commenced to use the same position for the sandboxes of its famous Class K engines, afterward known as D6 in the new classification, and after that time all passenger locomotives built by the company except a few known as class D2a (old BA), were built with sandboxes under the running boards until 1892, at which time there were several hundred engines so equipped in service on the main and subsidiary lines. After 1892 the top of the boiler was chosen as the company's standard position and as the engines came in for repairs the underhung sandboxes were removed and single ones placed on the tops of the boilers.

In the early '70s, some one at the Altoona shops fitted a freight locomotive with four small steam pipes leading to the front and rear of the drivers on each side of the engine, and so arranged them that a jet of steam could be blown directly under the wheels instead of sand when greater adhesion was desired. This device worked quite well, but objection was made to it on the ground that the moisture of the steam left the rails in a condition which caused following engines to slip unnecessarily, and after quite a prolonged trial the device was taken off.

Numerous illustrations made from photographs still in existence of engines built from the designs of Mr. Milholland for the Philadelphia & Reading during the "fifties" show these engines equipped with sandboxes under the running boards, and this position must still have been in use on that road as late as 1866, as an experimental engine built at Lancaster in the latter part of 1866 for the Pennsylvania was constructed in every particular from Reading drawings, and has its sandboxes under the running boards.

In 1874 the Pennsylvania arranged one of its 4-6-0 Baldwin freight engines as a "condensing" tank engine for street service in Pittsburgh, Pa., and sent it out without sandboxes as it was believed that its great weight (for those days) of 94,600 lbs., caused by the super-imposed tank, would give it sufficient adhesion under any condition of rail, but the sequel soon proved the fallacy of the idea, and sandboxes to be hung under the running boards were prepared under a rush order.

C. H. Caruthers

TURNING DRIVING WHEEL TIRES

Chicago, Ill., March 7, 1913.

To the Editor of the American Engineer:

Here is a report of a driving wheel tire turning test which was performed at Chicago shops of the Chicago & North Western, February 25, 1913, under the supervision of John Murrin, superintendent of shops. This test was undertaken to ascertain the number of pairs of wheels it was possible to do in one nine-hour day, taking the wheels as they came, on one machine. It will be found to compare favorably with the one published in the February issue of the *American Engineer* on page 62.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Diameter wheel, finished, in.	61	61	61	62½	62½	62½	62½	62½	62½	61¼	61¼	[illegible]	59⅞	59⅞	59⅞
Diameter wheel, rough, in.	61⅝	61⅝	61⅝	63	63	63	63	63	63	62	62	[illegible]	60½	60½	60½
Floor to chuck, minutes	9	6	6	5	6	7	5	6	5	5	5	6	7	5	7
Turning, minutes	28	29	29	24	21	23	29	27	22	17	22	27	28	18	21
Machine to floor, minutes	4	3	3	3	3	5	4	4	3	3	4	4	4	3	3
Total time, floor to floor, minutes	41	38	38	32	30	35	38	37	30	25	31	37	39	26	31
Cutting speeds, ft. per minute	14 to 19	14 to 18	15 to 20	15 to 20	14 to 20	15 to 20	13 to 15	15 to 20	15 to 20	15 to 20	15 to 20	15 to 20	15 to 20	15 to 20	15 to 20

The feed was ½ in. per revolution. Fifteen wheels were turned in 8 hrs. 28 mins. The average cutting time for each pair of wheels is 24.33 min., and from floor to floor 33.86 min. The quickest time for a single pair of wheels was 25 min. The test was made on a 90 in. heavy-duty Niles-Bement-Pond wheel lathe driven by a 50 h. p., d. c. General Electric motor.

E. H. Morey,
Shop Demonstrator, Chicago & North Western.

EXHIBITS OPEN IN THE EVENING

[Following the receipt of the letter from "Railroader," which was published on page 116 of the March issue, we addressed a communication to a small, selected list of railway and supply men who have been regular attendants at the Atlantic City conventions for a number of years, asking their opinion of the proposed plan. Practically all replied and a large majority were strongly in favor of having the exhibits held open at least part of the evenings during the convention. Extracts from a number of the answers received are given below. As we go to press, announcement is made that the exhibits will be held open this year on Monday evening, June 16. If it is found that advantage is taken of the opportunity this year (as the expressions of our correspondence clearly indicate it will be) it is planned to extend the practice to include several evenings at the 1914 conventions.—Editor.]

I am very strongly in favor of the plan. Many times I have wandered around by myself at night at the pier looking over the exhibits, without the aid of light or anyone to explain them to me, and I feel sure that there are a number of others who are in the same predicament as myself; that is, we have so many meetings in the day time that we have little or no time left to go over the exhibits.—*Superintendent of Motive Power.*

I doubt whether the exhibits would be of more value to me if kept open during the evening.—*Assistant Mechanical Engineer.*

I heartily approve of the suggestion as I find that in the limited time frequently allowed at the convention, not sufficient time has been found during the day to make as careful examination of exhibits as desired.—*Mechanical Engineer.*

I think it might be desirable to give the matter a trial, if it is entirely agreeable to the exhibitors.—*General Superintendent of Motive Power.*

I am of the opinion that possibly it would be advisable to have the exhibits open on two evenings.—*Superintendent of Rolling Stock.*

I am of the opinion that it would be a good thing to have the exhibits open possibly for two nights during each convention.—*Superintendent of Motive Power.*

The suggestion appeals to me personally. I have always felt that there was not sufficient opportunity to make an examination of exhibits commensurate with the expense the people went to in having them placed.—*General Superintendent of Motive Power.*

I favor the idea of keeping the exhibits on the pier open for a part of the evenings during the conventions.—*General Superintendent of Motive Power.*

I think a large number of railroad men would avail themselves of the opportunity to examine exhibits during the evening, and it seems to me that this plan would be worthy of a trial—*Mechanical Engineer.*

My experience has been, that it is impossible for me to go over the full lines of exhibits under the present plan, but it does not seem to me that evening sessions would help very much.—*Supervisor Motive Power and Machinery.*

I am not thoroughly convinced that if the exhibits were open in the evening, they would be very largely attended, but believe it would be worth trying out for this year.—*Assistant General Superintendent Motive Power.*

I believe it is the proper thing to do, but it will be somewhat of a hardship on the exhibitors.—*Assistant Superintendent Motive Power and Machinery.*

I think it is a good idea to keep the exhibits open at least every other evening during the convention.—*Master Mechanic.*

Such action would also tend to keep the convention people more together on the pier in the evening, and for one I should like to see it tried.—*General Mechanical Superintendent.*

Personally, I should like very much to see the exhibits open during the evening, as I find there are a number of them I have to pass over quickly.—*Superintendent of Motive Power and Rolling Stock.*

I believe that having the exhibits held open during the evenings would result not only advantageously to the manufacturers, but

to the members of the association.—*Assistant General Manager.*

In the writer's opinion it would be advisable to have the exhibits open for one evening during each convention.—*Engineer of Tests.*

I believe it would be beneficial to both the railroad men and supply men to hold the exhibits open to inspection during the evenings. Personally I should be very glad to take advantage of this opportunity, as I have found in the past that my time during the afternoon has been very limited, and while I have started off systematically to take in the exhibits, I have found it impossible to cover them as I should like to, because of the limited time at my disposal.—*Mechanical Engineer.*

I would, no doubt, avail myself one or two evenings of the advantage of having the exhibits open at night, and I believe that for those who come down but for a short time, this would be a desirable change. However, for the person who goes yearly to the convention and spends a week at Atlantic City, I do not see that this is necessary, as the new things which come up from year to year are very few and a great many of the exhibits represent the same thing every year.—*Engineer of Tests.*

I see no object in holding the exhibits open in the evening at the convention, and furthermore I do not see that members can be criticized if they devote the evening to relaxation. I consider it absolutely absurd to discuss the advisability of avoiding any period of relaxation at these conventions, while the enormous waste of time in spreading a convention of this kind over two weeks in place of one is neglected.—*Assistant to Vice-President.*

I am in favor of having the exhibits accessible during the evening, and one or more representatives of the exhibitors in attendance to meet those attending the convention who care to visit the exhibit during the evening. I do not believe it advisable to have the machinery in operation. If the exhibits are open during the evening I think the general public should not be admitted.—*Exhibitor.*

We think it would be a good policy to have the exhibits open in the evenings, especially on a minor scale, so that people who do not have an opportunity at other times could see them.—*Machine Tool Manufacturer.*

I have often wondered that there was not more made of the exhibits at night, as the people could stand around and chat just as well at the exhibits as they do in the big hotels.—*Mechanical Engineer.*

It should be remembered that in many cases, these affairs are the only vacations that master car builders, master mechanics and superintendents of motive power get, and if they cannot be trusted to attend the conventions and conduct themselves in a manner which will uphold the dignity of themselves, their positions, and the companies they represent, they should be kept at home, rather than be herded together on the pier in the evening, and at such other times as they may not be actually engaged in discussing subjects which the writer has had served up to him broiled for breakfast, warmed over for lunch, and cold for dinner for about a quarter of a century. Any master mechanic or master car builder who performs his duties in the manner expected of him is kept down to his work very closely for nearly every day in the year, and a little recreation once in a while will not be injurious to him, but will be of much benefit to the company that employs him, and personally, I believe that efforts should be directed toward discouraging well meaning but unwise people from offering what I consider nothing more or less than an insult to the body of men in charge of the mechanical departments of the railroads in this country, whose standard of excellence, dignity and honesty are as high as those of any other railroad official organization in existence.—*Superintendent of Motive Power.*

I believe this is a good suggestion and we shall be glad to do our share of whatever is necessary to carry it out.—*President of Large Supply Company.*

I believe it will be an excellent idea if it can be arranged one evening during each convention.—*Representative of Regular Exhibitor.*

MOVING PICTURES IN RAILWAY EDUCATIONAL WORK

Savannah, Ga., March 4, 1913.

To the Editor of the American Engineer:

I have noted with interest the article in the February issue of the *American Engineer* on the subject of "Moving Pictures in Railway Educational Work," and believe that your readers will be interested in knowing what the Central of Georgia's educational bureau is doing along this line.

The moving pictures referred to in the February number were taken on the Central of Georgia, under the direct supervision of D. C. Buell, of the Union Pacific, who is also chief of our educational bureau; and these pictures are therefore of particular interest to our employees, because of their strictly local character. The majority of our locomotive firemen are negroes, and a large percentage of them are not well enough educated to benefit by our educational courses. In order that these negro firemen may also receive benefits from our educational work, we adopted the plan of "showing" them the proper and improper methods of doing their work. It was with this as the prime object in view that the moving pictures were made. However, it has developed that these pictures are interesting and instructive to the white firemen, and also to the engineers. At one of our lectures at Macon, Ga., one of our oldest engineers remarked after the lecture that he had learned how to fire—that he never knew before. Several of the engineers and firemen have attended these lectures from three to five times, although there was no change in the lectures.

In addition to the moving pictures showing proper and improper methods of firing locomotives, we have gone a little further and included a lecture on train rules, and one on lost and damaged freight. We have selected the most important train rules; at least, the rules which have caused the men and the company the most trouble, and while the lecturer is talking about any particular rule, the rule itself is projected on the screen. We had lantern slides made of several photographs taken to show violations of certain rules and dangerous practices of trainmen. For instance, a photograph was shown of a blue flag properly placed to protect car men; one of a flagman who had failed to carry out Rule 99; another of a brakeman asleep at the switch; another showing a man riding on a brake wheel; and other photographs showing cars being kicked over road crossings; a man riding a brakebeam; kicking a coupler with the foot; adjusting the lock pin with the fingers; and last, but not least, a specially designed slide showing ALWAYS SAFETY FIRST.

We find that most of the trainmen are anxious to have these rules explained to them, and we believe that the method we have adopted has enabled us not only to reach a larger number, but to hold the interest and create a more lasting impression than we could have done with the ordinary lecture, or with any instruction matter we could have furnished.

Our lecture on lost and damaged freight was for the benefit of the agency forces and the local freight crews and the yard men. We had pictures showing the actual condition in which freight was received at destination, clearly indicating that it had been either improperly loaded or roughly handled by the train crew, sometimes both. These photographs were actual photographs taken by certain of our agents who had previously been furnished with kodaks for the purpose.

We have just completed a tour of the system, stopping only at the principal terminal points, and have lectured to 1,200 employees, including about 800 in train service, 200 in agencies, and 200 classified as miscellaneous. We have had comparatively little difficulty in getting the men to attend the lectures.

D. C. Boy,
Assistant Chief Educational Bureau.

LOCOMOTIVE CONNECTING RODS

Formulas and Constants Used by The Baldwin Locomotive Works Presented and Discussed

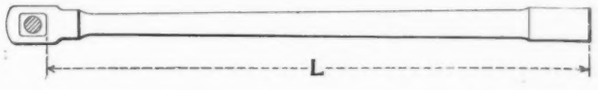
BY H. A. F. CAMPBELL.

The Master Mechanics' Committee of 1910 and 1911 on connecting rods, presented to the association an admirable and very complete report, that included the methods used by many railroads and some of the locomotive builders. The author proposes here to supplement that report by presenting more fully the standard method of figuring sizes and shapes of connecting rods used by the Baldwin Locomotive Works.

The loads and the resultant stresses on a set of connecting rods are many and varied. Possibly no two engineers would agree exactly on what loads to consider, much less on what their magnitude might be. The following formulas and tables are presented in their simplest form and can be easily understood and used. Furthermore they have been applied to the design of many connecting rods now running in the United States and foreign countries.

MAIN RODS.

(1) Rod as a strut in compression (locomotive just starting).



$$\frac{l}{r} = \frac{\text{Length L}}{\text{Least radius of gyration}} \quad \text{(Between 100 and 160.)}$$

$$\frac{P}{A} = 8{,}000 \text{ lbs. per sq. in.}$$

P = Load on main rod. (See Table I below.)
A = Least area of any section of the rod in the length L.
r = Radius of gyration. (For rectangular sections see Table VIII.)

8,000 lbs. per sq. in. = safe allowable working strength as a strut when L ÷ r is between 100 and 160 (see Table II giving the tests on full sized rods made by Prof. Lanza at the Massachusetts Institute of Technology).

TABLE I—LOAD *P* ON MAIN RODS.

2 cyl. simple.....	Area cyl. × full boiler pres. (See Table IV.)
4 cyl. balanced comp.	{ High pres. rods, = area high pres. cyl. × ½ boiler pres. { Low pres. rods, = area low pres. cyl × ½ boiler pres.
Mallet compound...	{ High pres. rods, = area high pres. cyl. × C. { Low pres. rods, = area low pres. cyl. × C_1.
	$C = \frac{.3 \text{ (Wt. on drivers)} \times \text{dia. drivers}}{\text{(Diam. H. P. cyl.)}^2 \times \text{stroke}}$ (See Table V.)
	$C_1 = \frac{.3 \text{ (Wt. on drivers)} \times \text{dia. drivers}}{\text{(Diam. L. P. cyl.)}^2 \times \text{stroke}}$ (See Table V.)
2 cyl. cross comp..	Area low pres. cyl. × K.
	$K = \frac{.3 \text{ (Wt. on drivers)} \times \text{dia. drivers}}{\text{(Diam. L. P. cyl.)}^2 \times \text{stroke}}$ (See Table V.)

(2) Rod as a beam loaded uniformly by centrifugal force and compression or tension due to piston load (locomotive traveling at high speed).

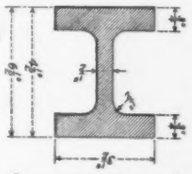
$$\text{Fiber stress per sq. in.} = f + f_1 = \frac{.28\, A\, V^2\, l^2}{16\, g\, r\, R} + \frac{C\, P}{A}$$

Fiber stress per sq. in. $f + f_1$ not to exceed 10,000 lbs. per sq.

TABLE II—CONNECTING ROD TESTS (FULL SIZE RODS). MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

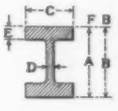
SERIES I SECTION TESTS MADE IN 1904.—Full-sized I Rods.

Rod.	$\frac{l}{r}$	Length, center to center.	Least radius of gyration.	Tensile Strength. Ultimate. Lbs. per sq. in.	Tensile Strength. Elastic limit. Lbs. per sq. in.	Tensile Strength. Elongation in 8 in. Per Cent.	Compressive Strength. Ultimate fiber stress. Lbs. per sq. in.	Compressive Strength. Working strength, factor of 4. Lbs. per sq. in.
A.....	100 in.	89⅜ in.	.8939	80,280	37,730	25.8	38,700	9,700
B.....	110 in.	98⅛ in.	.8939	78,830	45,650	20.8	40,600	10,150
C.....	120 in.	107¼ in.	.8939	77,840	43,900	20.4	39,300	9,825
D.....	125 in.	111¾ in.	.8939	79,270	47,560	22.3	35,400	8,850
E.....	130 in.	116⅛ in.	.8939	79,250	45,820	....	39,300	9,850
F.....	135 in.	120⅞ in.	.8939	81,660	49,440	24.1	39,300	9,850
G.....	140 in.	125⅛ in.	.8939	79,690	39,590	24.4	38,000	9,520
H.....	150 in.	134⅛ in.	.8939	78,650	39,470	21.0	37,400	9,300



Constant section and length varied.

SERIES II SECTION TESTS MADE IN 1906.—Full-sized I Rods.



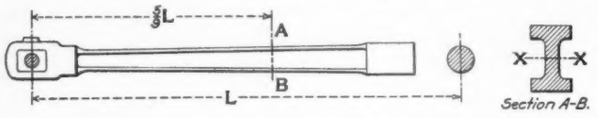
Rod.	$\frac{l}{r}$	Length, center to center.	Tensile Strength. Ultimate. Lbs. per sq. in.	Tensile Strength. Elastic limit. Lbs. per sq. in.	Tensile Strength. Elongation in 5 in. Per Cent.	Compressive Strength. Ultimate fiber stress. Lbs. per sq. in.	Compressive Strength. Working strength, factor 4. Lbs. per sq. in.	A	B	C	D	E
1 b....	129.6 in.	127¾ in.	69,290	26,310	29	29,410	7,353	5⅛ in.	6 5/16 in.	4 in.	7/16 in.	11/16 in.
2 b....	130.1 in.	127¾ in.	72,140	24,340	25.8	26.420	6,605	5 7/32 in.	6⅜ in.	4 in.	13/32 in.	11/16 in.
3 b....	129.6 in.	127¾ in.	72,500	27,380	28.2	31,600	7,900	5 31/32 in.	7⅛ in.	4 in.	⅜ in.	11/16 in.
4 b...	129.4 in.	127¾ in.	68,170	25,720	30.2	26,400	6,600	5 31/32 in.	7⅛ in.	4 in.	5/16 in.	11/16 in.
5 b....	130.4 in.	127¾ in.	74,740	30,500	25.4	32,390	8,097	5 31/32 in.	7 5/32 in.	4 in.	¼ in.	11/16 in.
6 b....	129.4 in.	127¾ in.	75,600	26,750	24.6	28,750	7,190	6 7/32 in.	7 15/16 in.	4¼ in.	5/16 in.	11/16 in.

SERIES II SECTION TESTS MADE IN 1906.—Full-sized I Rods.

Rod.	Length of span.	Tensile Strength. Ultimate. Lbs. per sq. in.	Tensile Strength. Elastic limit. Lbs. per sq. in.	Tensile Strength. Elongation in 5 in. Per Cent.	Modulus of Rupture. Lbs. per sq. in.
1 a.....	132¼ in.	.....	.....	....	44,120
2 a.....	133 in.	76,000	31,110	22.4	49,990
3 a.....	131½ in.	67,970	25,750	28.6	44,180
4 a.....	134 in.	65,420	32,190	29.0	41,210
5 a.....	136.8 in.	75,250	28,160	22.6	41,440
6 a.....	142½ in.	.....	30,000	25.2 in 8 in.	45,130
X.....	122½ in.	90,550	41,620	15.6	86,670
Y.....	96.5 in.	83,020	42,230	20.3	71,880

Same dimensions of A, B, C, D, E, as given above.

in. at a speed equal to the diameter of the drivers in inches.



Maximum whip action at a section $\frac{5}{9}$ L from the crosshead pin—section AB

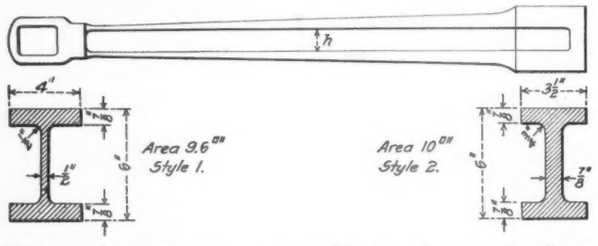
$$\frac{A \times V^2}{g \times r \times R} = C$$

A = Area of section A B in square inches.
V = Linear velocity of the crank pin in feet per second.

(If the speed is taken as, "diameter speed," i. e., if a 62 in. diameter driver, 62 miles an hour; 84 in. diameter driver, 84 miles an hour, etc., then V = 1.466 × stroke in inches [see Table XI]).

l = Length of rod center to center in inches.
g = Gravity = 32.16.
r = Radius of the crank in feet. (See Table XI.)
R = Resistance of section A B about axis X X.
C = Per cent. of full boiler pres. due to speed and cut off and the effect of various heating surfaces. (See Diagram III.)
P = Area of piston times the full boiler pressure. (See Table IV.)

For $\frac{A}{R}$ of rectangular sections see Table X.



Mill or plane out a constant width *h* and taper the flanges. The section shown in style 2 is preferred to style 1 for main rods. Flanges less than ¾ in. thick should not be used.

SIDE RODS.

(1) The rod as a strut in compression.

The loading on each side rod, to be used for the maximum compression loads on the rods, and the loads on the rod stubs and strength of side rod wrist pins are given in per cent. of the main rod load, P in Diagram VI.

These resultant loads can only be obtained at starting, and include a factor for shock, due to worn pins and brasses, uneven tramming of the rods, uneven alinement of the wheels, slipping of one wheel and transferring its load to another and catching the wheels on sand when slipping. These forces are hard to determine, and have been included in one general factor. This same loading on the side rods would be obtained if a factor of adhesion of about .4 were used. This may seem high, but experience has shown that this loading on side rods in conjunction with the method of figuring the strength as given here does not give a greater margin of safety than is necessary.

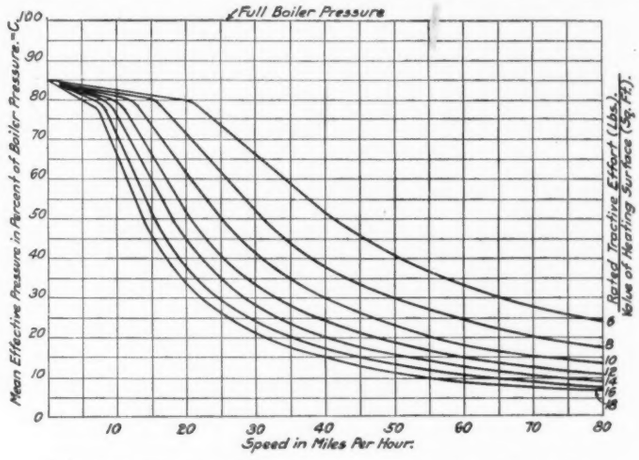

% Full Boiler Pressure
Mean Effective Pressure in Percent of Boiler Pressure = C
Rated Tractive Effort (Lbs.)
Value of Heating Surface (Sq. Ft.)
Speed in Miles Per Hour.

Diagram III—Mean Effective Pressure in the Cylinders.

The least sectional area of the rod is first tested as a strut (locomotive starting).

(a) If the rod section is I use a working strength of 8,000 lbs. per sq. in. when $\frac{L}{r}$ is between 100 and 160.

(b) If the section is rectangular the working strength is taken

Table V—Piston Loads for Low Pressure Cylinders.

Diameter of Cylinder.	Pressures, Pounds. 60	70	75	80	85	90	95	100
20 in...	18,850	21,991	23,600	25,133	26,700	28,274	29,850	31,416
21 in...	20,782	24,245	26,000	27,709	29,400	31,173	32,800	34,636
22 in...	22,808	26,609	28,500	30,411	32,300	34,212	36,100	38,013
23 in...	24,929	29,083	31,120	33,238	35,300	37,393	39,400	41,548
24 in...	27,143	31,667	33,900	36,191	38,400	40,715	42,900	45,239
25 in...	29,400	34,300	36,800	39,200	41,650	44,100	46,500	49,090
26 in...	31,900	37,200	39,800	42,500	45,100	47,800	50,400	53,090
27 in...	34,400	40,150	43,000	45,900	48,600	51,600	54,400	57,300
28 in...	36,950	43,100	46,200	49,300	52,300	55,400	58,500	61,600
29 in...	39,600	46,200	49,500	52,800	56,100	59,400	62,700	66,000
30 in...	42,400	49,500	53,000	56,600	60,100	63,600	67,200	70,700
31 in...	45,300	52,800	56,600	60,400	64,200	68,000	71,700	75,500
32 in...	48,300	56,300	60,300	64,300	68,300	72,400	76,400	80,400
33 in...	51,300	59,860	64,100	68,400	72,700	77,000	81,200	85,500
34 in...	54,500	63,550	68,100	72,700	77,200	81,700	86,200	90,800
35 in...	57,700	67,350	72,200	77,000	81,800	86,600	91,400	96,200
36 in...	61,000	71,240	76,300	81,400	86,500	91,600	96,700	101,790
37 in...	64,500	75,300	80,700	86,000	91,400	96,800	102,500	107,500
38 in...	68,100	79,400	85,100	90,700	96,400	102,000	108,000	113,400
39 in...	71,700	83,600	89,500	95,500	101,500	107,500	113,500	119,500
40 in...	75,500	87,900	94,200	100,500	107,000	113,000	119,500	125,600
41 in...	79,200	92,400	99,000	105,600	112,000	118,500	125,500	132,000
42 in...	83,100	97,000	104,000	111,000	117,500	125,000	132,500	138,500

Table IV—Piston Loads (*P*).
Area of Cylinder × Full Boiler Pressure.

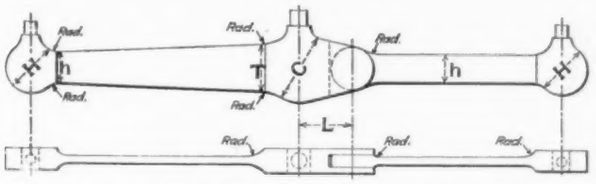
Diameter of Cylinder.	Boiler Pressure, Pounds. 130	140	150	160	170	180	185	190	200	205	210	220
5 in.....	2,553	2,749	2,945	3,142	3,338	3,534	3,630	3,731	3,927	4,020	4,123	4,330
6 in.....	3,675	3,958	4,240	4,523	4,806	5,089	5,240	5,372	5,655	5,800	5,938	6,221
7 in.....	5,002	5,387	5,772	6,157	6,542	6,926	7,120	7,311	7,696	7,900	8,082	8,467
8 in.....	6,534	7,036	7,539	8,042	8,544	9,047	9,300	9,549	10,053	10,300	10,556	11,059
9 in.....	8,269	8,905	9,541	10,178	10,813	11,450	11,770	12,086	12,722	13,040	13,358	13,996
10 in.....	10,210	10,995	11,781	12,566	13,352	14,137	14,520	14,992	15,708	16,100	16,493	17,278
11 in.....	12,354	13,304	14,254	15,205	16,155	17,105	17,570	18,055	19,005	19,470	19,957	20,907
12 in.....	14,703	15,834	16,965	18,096	19,277	20,358	20,900	21,489	22,620	23,100	23,751	24,882
13 in.....	17,255	18,582	19,909	21,237	22,564	23,891	24,600	25,218	26,545	27,270	27,874	29,201
14 in.....	20,012	21,552	23,091	24,630	26,170	27,709	28,500	29,248	30,788	31,600	32,327	33,866
15 in.....	22,972	24,739	26,506	28,274	30,040	31,807	32,700	33,574	35,341	36,200	37,110	38,877
16 in.....	26,138	28,148	30,159	32,170	34,180	36,191	37,200	38,201	40,212	41,200	42,223	44,234
17 in.....	29,507	31,777	34,047	36,317	38,587	40,856	42,000	43,126	45,396	46,500	47,666	49,936
18 in.....	33,081	35,626	38,170	40,715	43,259	45,804	47,000	48,349	50,894	52,100	53,339	55,784
19 in.....	36,859	39,694	42,529	45,365	48,200	51,035	52,300	53,870	56,706	58,000	59,541	62,376
20 in.....	40,841	43,981	47,124	50,266	53,407	56,549	58,100	59,690	62,832	64,400	65,974	69,116
21 in.....	45,027	48,490	51,954	55,418	58,881	62,345	64,000	65,808	69,272	70,900	72,736	76,200
22 in.....	49,414	53,218	57,019	60,821	64,622	68,423	70,300	72,224	76,026	77,900	79,828	83,629
23 in.....	54,012	58,167	62,322	66,477	70,632	74,786	76,900	78,941	83,096	85,200	87,250	91,405
24 in.....	58,811	63,335	67,858	72,382	76,906	81,430	83,700	85,954	90,478	92,800	95,002	99,526
25 in.....	.....	.....	.....	.....	.....	.....	90,800	93,200	98,100	100,600	103,000	108,000
26 in.....	.....	.....	.....	.....	.....	.....	98,200	101,000	106,200	108,800	115,000	116,800
27 in.....	.....	.....	.....	.....	.....	.....	106,000	108,600	114,600	117,400	120,600	126,000
28 in.....	.....	.....	.....	.....	.....	.....	114,000	117,000	123,200	126,200	129,300	135,500
29 in.....	.....	.....	.....	.....	.....	.....	122,100	125,500	132,100	135,400	139,000	145,200
30 in.....	.....	.....	.....	.....	.....	.....	130,800	134,300	141,400	145,000	148,400	155,000

from Table VIII. (Based on tests made by the Pencoyd Iron Works.)

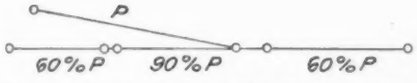
Next test the rods as a beam loaded uniformly by centrifugal force and compression or tension due to the piston load (Diagram VII).

Fiber stress per square inch $= f = \frac{.28\,A\,V^2\,l^2}{8\,g\,r\,R}$ $\quad f_1 = \frac{\%\,C\,P}{A}$

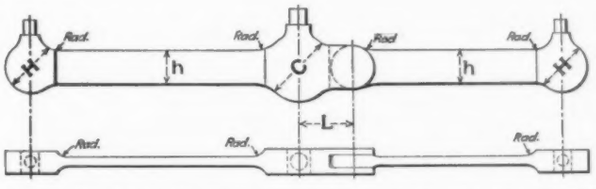
$f + f_1$ should not exceed 10,000 lbs. per sq. in. at "diameter speed."



When C is 13 in. in diameter and over increase h to T as shown above.



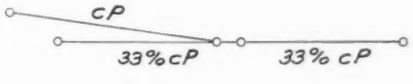
When C is less than 13 in. in diameter make the rod section style as given below.

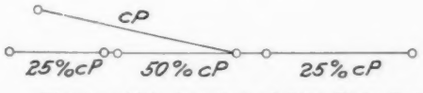


The following rules are important and should be carefully followed:

h shall be at least ½ H : better ⅔ H.

Use large radii as shown.





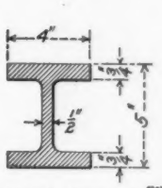
If possible have no side sets in the rods.

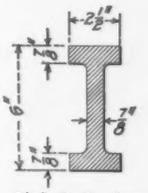
Use the style of jaws as shown.

Keep the overhang, L, as short as possible.

Unless the side rods are over 90 in. center to center use a rectangular section *deep and thin.*

For side rods over 90 in. center to center use an I section.



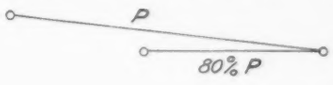


The many and various stresses will be withstood better by the section shown as style 2, than by that designated as style 1.

Don't use flanges less than ¾ in. thick.

WRIST PINS AND CROSSHEAD PINS.

The sizes of wrist and crosshead pins are fixed by the amount of wearing surface necessary, and by the limits of the fiber stresses produced by the loads on the rods.



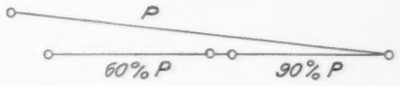
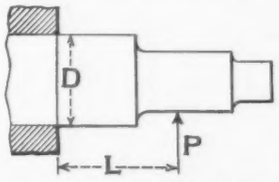
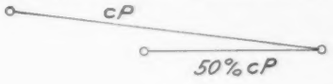


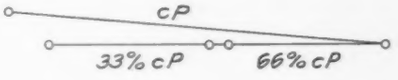
Diagram VI—Loading of Side Rods for Strength of Rods and Stubs. Locomotive Developing Its Maximum Tractive Effort at Starting.

1.—*Diameter of the Pin for Strength.*



P = Load on the main rod. (See Tables I, IV, V.)
P_1 = Load on the side rods. (See Table VI.)
L = Distance as shown.
R = Resistance of the pin for bending at D, pin worn ¼ in. (See Table XII.)
Assume no support from side rods for calculations on the main pin.
f = Allowable working fiber stress;
= 18,000 lbs. per sq. in. for open-hearth steel;





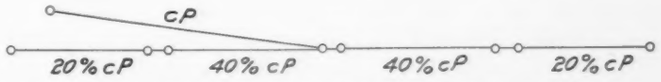


Diagram VII—Loading of Side Rods Due to Reduced Main Rod Load C P (Diagram III). Locomotive Travelling at High Speed.

= 15,000 lbs. per sq. in. for wrought iron;

$$= \frac{P \times L}{R}$$

2.—*Size of Pins for Wearing Pressure.*—The wearing surface and size are based on a load P as given in Table I.

Wearing pressure per sq. in. strap stubs with keys = 1,600 to 1,800 lbs.

Wearing pressure per sq. in. solid end stubs, no key = 1,000 to 1,200 lbs.

Table VIII—Rectangular Steel Rods in Compression.
(Tests made by Pencoyd Iron Works.)

l/r	Working comp. strength. Pounds per sq. in.	Factor of safety of ult. strength.	l/r	Working comp. strength. Pounds per sq. in.	Factor of safety of ult. strength.
20	21,900	3.2	140	6,410	4.4
30	15,400	3.3	150	5,950	4.5
40	13,500	3.4	160	5,500	4.6
50	12,600	3.5	170	4,980	4.7
60	11,700	3.6	180	4,460	4.8
70	10,800	3.7	190	3,960	4.9
80	10,000	3.8	200	3,580	5.0
90	9,260	3.9	210	3,180	5.1
100	8,550	4.0	220	2,880	5.2
110	8,070	4.1	230	2,640	5.3
120	7,590	4.2	240	2,410	5.4
130	7,000	4.3			

Table IX—Radius of Gyration for Rectangular Sections in Terms of Least Side.

Least side.	Radius of gyration.	Least side.	Radius of gyration.	Least side.	Radius of gyration.	Least side.	Radius of gyration.
½	.1443	1 1/16	.343	1 7/8	.542	2 5/16	.740
5/8	.1805	1 1/4	.361	1 15/16	.560	2 3/8	.758
3/16	.1625	1 5/16	.379	2	.578	2 7/16	.776
11/16	.198	1 3/8	.397	2 1/16	.596	2 1/2	.795
3/4	.217	1 7/16	.415	2 1/8	.614	2 9/16	.812
13/16	.234	1 1/2	.433	2 3/16	.632	2 5/8	.831
7/8	.253	1 9/16	.451	2 1/4	.650	2 11/16	.848
15/16	.270	1 5/8	.470	2 5/16	.668	3	.867
1	.289	1 11/16	.487	2 3/8	.686		
1 1/16	.307	1 3/4	.505	2 7/16	.704		
1 1/8	.325	1 13/16	.524	2 1/2	.722		

Table X—Rectangular Rods in Motion.

$$\text{Ratio} = \frac{\text{Area of Section}}{\text{Resistance of Section}} = \frac{A}{R}$$

Depth of Rod. In.	A/R	Depth of Rod. In.	A/R	Depth of Rod. In.	A/R	Depth of Rod. In.	A/R
2	3.000	3½	1.714	4¾	1.263	6	1.000
2¼	2.666	3¾	1.600	5	1.200	6¼	0.96
2½	2.400	4	1.500	5¼	1.143	6½	0.925
2¾	2.181	4¼	1.411	5½	1.091	6¾	0.888
3	2.000	4½	1.333	5¾	1.043	7	0.857
3¼	1.846						

Table XI—Value of V², 16 g r, 8 g r for Different Length of Strokes at a Velocity Equal to "Diameter Speed."

Stroke. In.	16 g r	V²	8 g r	Stroke. In.	16 g r	V²	8 g r
10....	214.4	215.0	107.2	25½..	546.6	1,400.0	273.3
12....	257.3	309.5	128.6	26....	557.1	1,453.0	278.5
14....	300.1	421.3	150.0	27....	578.8	1,567.0	289.4
16....	343.0	550.3	171.5	28....	600.0	1,685.0	300.0
18....	385.0	696.7	197.5	29....	621.5	1,808.0	310.7
20....	428.7	869.4	214.3	30....	643.2	1,934.0	321.6
22....	471.7	1,040.0	235.8	31....	664.2	2.066.0	332.1
24....	514.5	1,238.0	257.2	32....	686.0	2,201.0	343.0
25....	535.9	1,343.0	267.9	34....	728.9	2.485.0	364.4

Table XII—Moment of Resistance of Circular Sections.

Diam. In.	Moment.	Diam. In.	Moment.	Diam. In.	Moment.	Diam. In.	Moment.
1¼....	.1917	3¼....	3.3702	5¼....	14.206	7¼....	37.412
1⅜....	.2552	3⅜....	3.7742	5⅜....	15.247	7⅜....	39.381
1½....	.3313	3½....	4.2093	5½....	16.334	7½....	41.418
1⅝....	.4213	3⅝....	4.6765	5⅝....	17.474	7⅝....	43.523
1¾....	.5262	3¾....	5.1772	5¾....	18.664	7¾....	45.699
1⅞....	.6472	3⅞....	5.7124	5⅞....	19,908	7⅞....	47.947
2....	.7854	4....	6.2832	6....	21.206	8....	50.266
2⅛....	.9423	4⅛....	6.8924	6⅛....	22.559	8⅛....	52.659
2¼....	1.1182	4¼....	7.5365	6¼....	23.968	8¼....	55.127
2⅜....	1.3152	4⅜....	8.2212	6⅜....	25.436	8⅜....	57.671
2½....	1.534	4½....	8.9463	6½....	26.962	8½....	60.292
2⅝....	1.7758	4⅝....	9.7126	6⅝....	28.547	8⅝....	62.991
2¾....	2.0417	4¾....	10.512	6¾....	30.194	8¾....	65.770
2⅞....	2.3333	4⅞....	11.375	6⅞....	31.902	8⅞....	68.629
3....	2.6507	5....	12.272	7....	33.764	9....	71.569
3⅛....	2.9962	5⅛....	13.215	7⅛....	35.510		

Wearing pressure per sq. in. crosshead stubs and knuckles = 4,500 to 5,500 lbs.

The wearing surface is the projected area of the brass.

STRAP STUBS.

For wrought steel straps:

Working stress, direct tension = 10,000 lbs. per sq. in.

Table XIII—Proportions of P Used on the Different Pins.

Class of Engine.	Cross-head Pin.	Main Pin.	Side Rods. Main Pin.	Inter Pins.	End Pins.	Knuckle Pins.
2 Coupled.....	P	P	½ P	....	½ P	....
3 Coupled.....	P	P	⅔ P	⅓ P	⅓ P	.7 P
4 Coupled.....	P	P	¾ P	¼ P	¼ P	.6 P
5 Coupled.....	P	P	⅘ P	⅕ P	⅕ P	.5 P

Working stress, direct tension through keyways = 8,000 lbs. per sq. in.

Working stress, bending = 14,000 lbs. per sq. in. (main rods).

Table XIV—Carrying Capacity of Wrought Steel Bolts in Shear at 9,000 Lbs. per Sq. In.

2 in. Double Shear. Bolts.	Strength.	3 in. Double Shear. Bolts.	Strength.
½	7,070 lbs.	5/8	16,550 lbs.
5/8	11,040 lbs.	¾	23,850 lbs.
¾	15,900 lbs.	7/8	32,470 lbs.
7/8	21,600 lbs.	1	42,400 lbs.
1	28,300 lbs.	1⅛	53,680 lbs.
1⅛	35,800 lbs.	1¼	66,250 lbs.
1¼	44,180 lbs.	1⅜	80,180 lbs.
1⅜	53,450 lbs.	1½	95,400 lbs.
1½	63,600 lbs.	1⅝	111,500 lbs.
1⅝	74,500 lbs.	1¾	129,900 lbs.
1¾	86,500 lbs.	1⅞	149,000 lbs.
1⅞	99,500 lbs.	2	170,000 lbs.
2	113,000 lbs.		

Working stress, bending = 20,000 lbs. per sq. in. (side rods).

Shear on steel stub bolts = 9,000 lbs. per sq. in. (See Table XIV.)

SOLID END STUBS, MAIN OR SIDE AND SOLID END JAW STUBS.

Direct tension at section a-a and c-c under maximum loads (as already given) must not exceed 6,000 lbs. per sq. in. at any section of the strap.

The straps or eye must also be tested for bending, using P and the per cent. of P as already given.

Main rods at section d, No. 2,

$$f = 14{,}000 = \frac{P \times l \times 6}{16 \times b \times h^2}$$

Main rod at section b, No. 3,

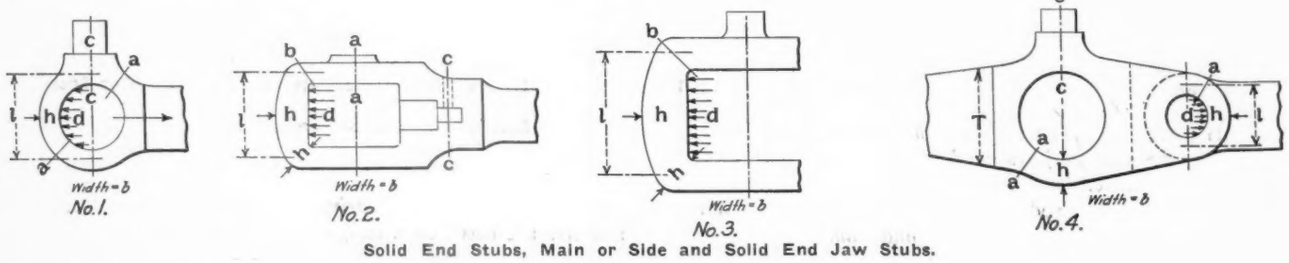
$$f = 14{,}000 = \frac{P \times l \times 6}{12 \times b \times h^2} + \frac{P}{2 \times b \times h}$$

Side rods at section d, Nos. 1 and 4,

$$f = 20{,}000 = \frac{\% P \times l \times 6}{16 \times b \times h^2}$$

At a section c-c, through an oil cup or set screw, it is better to have 25 per cent. more area than at section a.

In No. 4 the main part of the strap at section a-a is subjected to a bending action. Any method of figuring this bending is rather unsatisfactory. It is, therefore, better to try to eliminate the cause of this bending action. To some extent this can be done by increasing the depth of the rod at T and using large fillets 20 in. to 40 in. radius as already shown in Nos. 1 and 2. The purpose of this method of design is to reduce too



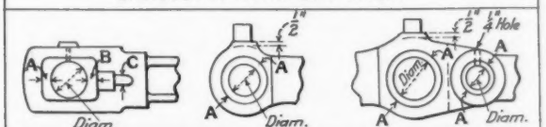
Solid End Stubs, Main or Side and Solid End Jaw Stubs.

sharp a change in the direction of the load as it goes across the top or bottom of the strap. If this is done the strap can be checked for its required area on the direct tension basis alone, using, as already stated, a working stress of 6,000 lbs. per sq. in. It must be carefully noted that the required area can be made up of many combinations of h × b, and careful judgment must be used to determine h.

Table XV gives the recommended size of brasses and jaw bushings for solid end stubs.

Table XV.—Dimensions of Solid End Brasses.

Brasses for Solid End Stubs.

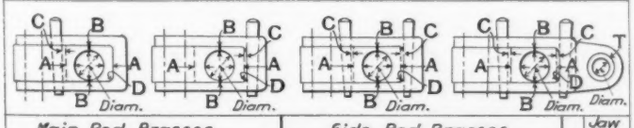


Crosshead Stubs				End Stubs				Jaw Stubs				Jaw Pins		
Diam.	A	B	C	Diam.	A	Diam.	A	Diam.	A	Diam.	A	Diam.	Iron or Steel T	Brass T
1½	3/8	1/2	3/4	2½	1/2	7	1 5/8	3	5/8	7¾	1 5/8			
1¾	3/8	1/2	3/4	2¾	1/2	7¼	1 5/8	3¼	5/8	8	1 5/8	1	1/4	1/4
2	1/2	3/4	3/4	3	5/8	7½	1 5/8	3½	5/8	8¼	1/4	1¼	1/4	1/4
2¼	5/8	7/8	7/8	3¼	5/8	7¾	1 5/8	3¾	3/4	8½	1/4	1½	1/4	5/8
2½	5/8	7/8	7/8	3½	5/8	8	1 5/8	4	3/4	8¾	1/4	1¾	1/4	5/8
2¾	5/8	7/8	7/8	3¾	3/4	8¼	1/4	4¼	3/4	9	1/4	2	1/4	5/8
3	3/4	1	1	4	3/4	8½	1/4	4½	3/4			2¼	1/4	5/8
3¼	3/4	1	1	4¼	3/4	8¾	1/4	4¾	3/4			2½	1/4	5/8
3½	3/4	1	1	4½	3/4	9	1/4	5	3/4			2¾	1/4	5/8
3¾	1	1	1½	4¾	3/4			5¼	7/8			3	3/8	1/2
4	1	1	1½	5	3/4			5½	7/8			3½	3/8	1/2
4¼	1	1	1½	5¼	7/8			5¾	7/8			3¾	3/8	1/2
4½	1	1	2¼	5½	7/8			6	7/8			4	3/8	1/2
4¾	1	1	2¼	5¾	7/8			6¼	1			4½	1/2	5/8
5	1	1	2¼	6	7/8			6½	1					
5¼	1	1	2¼	6¼	1			7	1 5/8					
5½	1¼	1¼	2¼	6½	1			7¼	1 5/8					
5¾	1¼	1¼	2¼	6¾	1			7½	1 5/8					

Table XVI gives the recommended size of brasses and jaw bushings, size of liner behind the keys, radius of the fillet at the corner of the strap, and the number of bolts for the strap stubs.

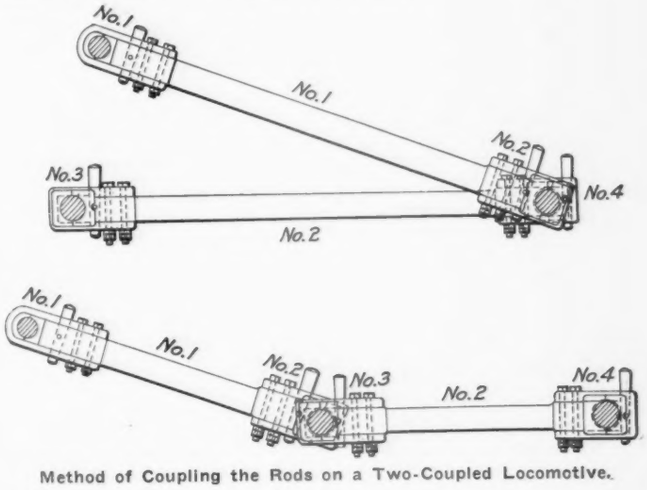
Table XVI.—Dimensions of Strap End Brasses.

Brasses for Strap Stubs.

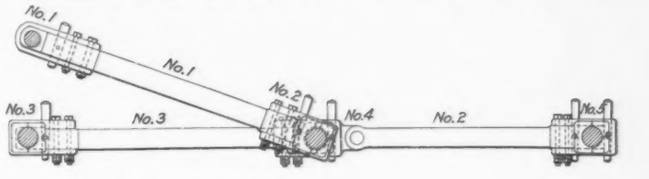


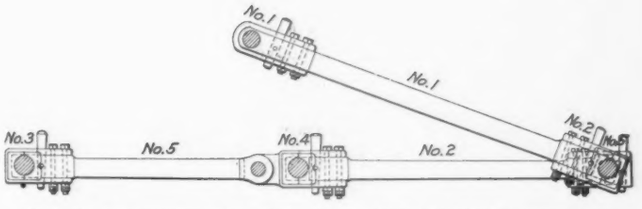
Main Rod Brasses						Side Rod Brasses						Jaw Pins	
Diam.	No. of Bolts	A	B	C	D	Diam.	No. of Bolts	A	B	C	D	Diam.	Iron or Steel T	Brass T
1½	2	3/8	1/4	3/8	1/2	1½	2	1/8	1/4	1/2	3/4			
1¾	2	3/8	1/4	3/8	1/2	1¾	2	1/8	1/4	1/2	3/4	1	1/4	1/4
2	2	5/8	1/4	3/8	1/2	2	2	1/8	1/4	1/2	3/4	1¼	1/4	1/4
2¼	2	5/8	1/4	3/8	1/2	2¼	2	1/8	1/4	1/2	3/4	1½	1/4	5/8
2½	2	5/8	1/4	3/8	1/2	2½	2	1/8	1/4	1/2	3/4	1¾	1/4	5/8
2¾	2	5/8	1/4	3/8	1/2	2¾	2	1/8	1/4	1/2	3/4	2	1/4	5/8
3	2	3/4	1/4	3/8	1/2	3	2	1/8	1/4	1/2	3/4	2¼	1/4	5/8
3¼	2	3/4	1/4	3/8	1/2	3¼	2	1/8	1/4	1/2	3/4	2½	1/4	5/8
3½	2	7/8	1/4	3/8	1/2	3½	2	1/8	1/4	1/2	3/4	2¾	1/4	5/8
3¾	2	1"	1/4	3/8	1/2	3¾	2	1/8	1/4	1/2	3/4	3	3/8	1/2
4	2	1⅛	1/4	3/8	1/2	4	2	1/8	1/4	1/2	3/4	3½	3/8	1/2
4¼	2	1⅛	1/4	3/8	1/2	4¼	2	1/8	1/4	1/2	3/4	3¾	3/8	1/2
4½	2	1¼	1/4	3/8	1/2	4½	2	1/8	1/4	1/2	3/4	4	3/8	1/2
4¾	2	1⅜	1/4	3/8	3/4	4¾	2	1/8	1/4	1/2	3/4	4½	1/2	5/8
5	2	1½	1/4	3/8	3/4	5	2	1/8	1/4	1/2	3/4			
5¼	2	1½	1/4	3/8	3/4	5¼	2	1/8	1/4	1/2	3/4			
5½	2	1⅝	1/4	3/8	3/4	5½	2	1/8	1/4	1/2	3/4			
5¾	2	1⅝	1/4	3/8	3/4	5¾	2	1/8	1/4	1/2	3/4			

With Brasses 6½" and Wider use Wedges.

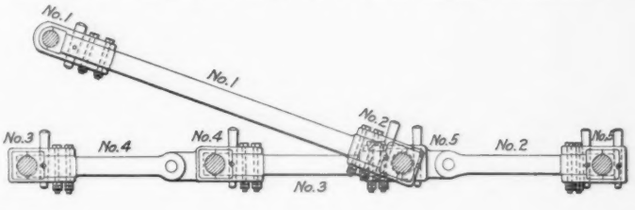


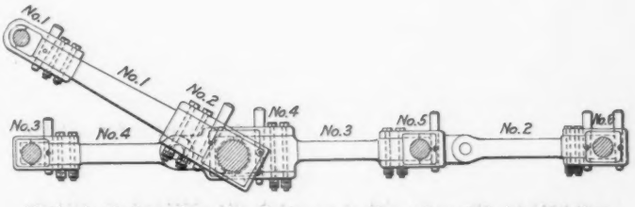
Method of Coupling the Rods on a Two-Coupled Locomotive.



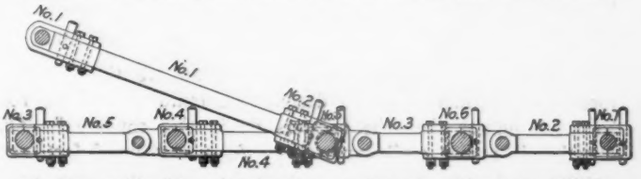


Method of Coupling the Rods on a Three-Coupled Locomotive.





Method of Coupling the Rods on a Four-Coupled Locomotive.

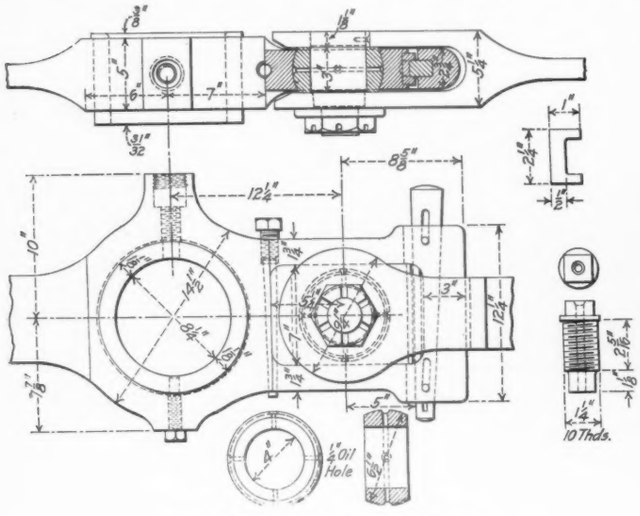


Method of Coupling the Rods on a Five-Coupled Locomotive.

KNUCKLE PINS AND JAWS.

Knuckle pins must have ample bearing surface and the pressure per square inch, with the loads given in Table XIII, should not exceed 5,500 lbs. per sq. in.

The lateral displacement of side rods due to the difference of alinement of one driver with another, together with the permanent side set that some side rods are designed to work with,



Ball Knuckle Pin for Side Rods.

cause excess twisting strains that often result in the failure of the rod.

Allow 1/16 in. total play between the jaw and its side wings.

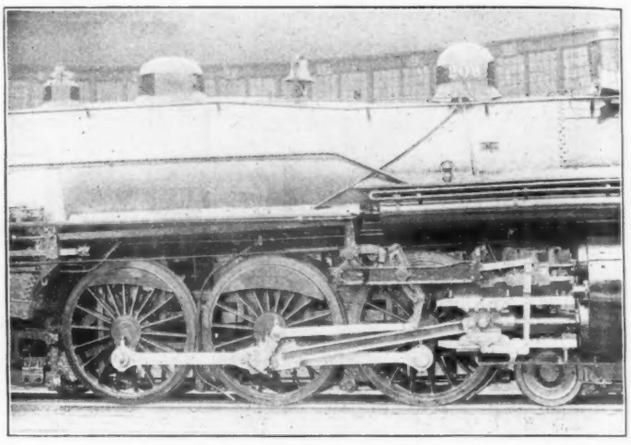
On five coupled engines, and even on four coupled that operate on very sharp curves, a ball knuckle pin will greatly reduce the excessive strains mentioned above. The type of ball knuckle pin here shown has been used on some of the latest Baldwin Mikados and five coupled engines.

The following set of rods shows a design used on a large order of high powered Pacific type locomotives. This design represents Baldwin standard practice, and was based on the rules here given. The main rod is the one referred to later in the comparative table of the weight of rods.

COMPARISON BETWEEN AMERICAN AND FOREIGN ROD DESIGN.

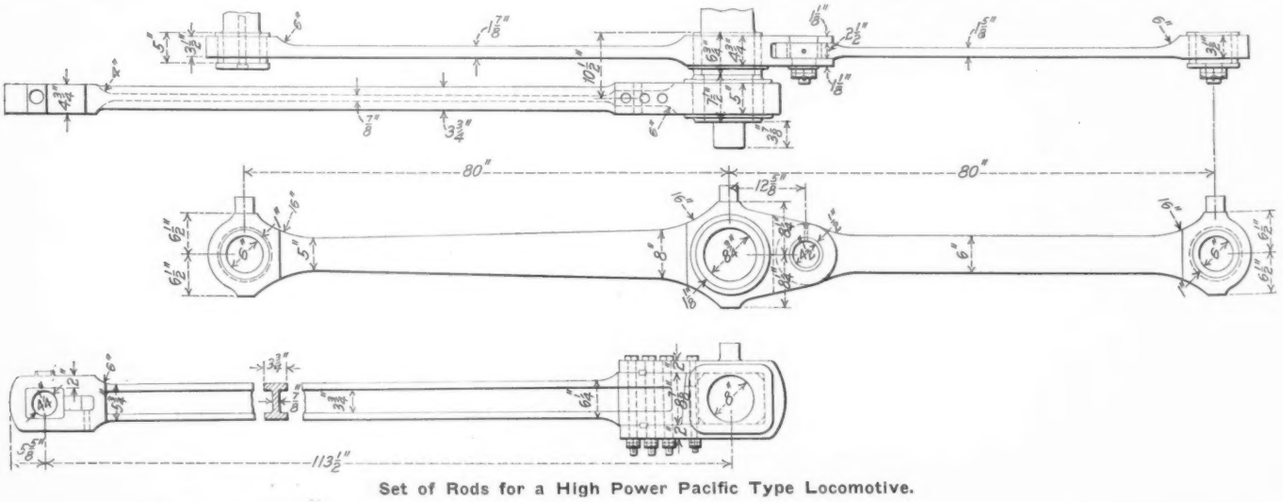
Frequently, the question is asked, "Why are the European locomotive builders able to design and build connecting rods so much lighter than the builders do in this country?" This question is rather easily answered. As a matter of fact, connecting rods on European locomotives are not very much lighter, in proportion to the loads they carry, than the rods on locomotives in the United States. European rods look very light, but the basis of comparison must not be made on looks but on the amount of load or work that each rod carries per unit of weight.

The conditions in Europe may be summed up briefly as follows: The connecting rods are of hammered iron, or 80,000 lbs. open hearth steel. The allowable load at the rail on one driving axle seldom exceeds 20 tons. The main and side rods are made as short as possible. In many cases the total work is divided between four main rods. The stroke of the pistons is seldom over 26 in. With English inside cylinder locomotives the side rods outside revolve at a shorter throw than the main rods inside, thus reducing the whip of the side rods at high speed. The rod brasses, straps and pins are maintained in first class condition.



Connecting Rods of a High Power Pacific Type Locomotive.

The conditions in the United States are as follows: The connecting rods are of 80,000 lbs. per sq. in. open hearth steel. The allowable load at the rail per driving axle is 35 tons, and the limit of loading possibly has not yet been reached. The main rods are often very long. Two Atlantic type locomotives in this country have main rods 150 in. center to center, and many are 130 in. to 140 in. long. Except on the balanced compounds and Mallets the loads are all carried through one main rod on each side. The maximum load carried on one main rod has reached the high figure of 110,000 lbs. or 55 tons. The stroke of our pistons is seldom less than 26 in., and very often is 28 in., 30 in. and 32 in. The rod brasses and pins are not always maintained in first class condition.



Set of Rods for a High Power Pacific Type Locomotive.

The contrast as outlined would indicate that the American rods would be much heavier, and they are actually heavier as a whole. But when compared on the basis of the amount of load carried per pound of weight of the rod, it will be found that there is not a great deal of difference. The following table shows this.

The data on European rods is limited, but more examples would probably show that as many rods carry 100 lbs. and less per pound weight of rod as there are that carry over 100 lbs.

EUROPEAN MAIN RODS.

Name of Road.	Type of locomotive.	Cylinders and boiler pressure.	Length of main rod, center to center. High pressure.	Maximum load on the main rod. High pressure.	Actual weight of the main rod.	Pounds of load carried per pound of rod.
Paris-Orleans	4-6-0 De Glehn comp.	15 in. & 24 in. x 25 in. 227 lbs.	83½ in.	35,800 lbs.	283 lbs.	126 lbs.
Great Western—England	4-6-0 2 cyl. simple	18 in. x 30* in. 220 lbs.	128½ in.	55,800 lbs.	500 lbs.	111 lbs.
North British	4-4-2 2 cyl. simple	20 in. x 28* in. 200 lbs.	135 in.	62,800 lbs.	600 lbs.	104½ lbs.
Lancashire and Yorkshire	4-6-0 4 cyl. simple	16 in. x 26 in. 180 lbs.	128 in.	36,180 lbs.	438¾ lbs.	82 lbs.
					Average....	105 lbs.

*Exceptionally long stroke for British practice.

UNITED STATES PRACTICE.

N. Y., N. H. & H.	4-6-0 2 cyl. simple	21 in. x 26 in. 200 lbs.	128 in.	69,200 lbs.	692 lbs.	100 lbs.
Lehigh Valley	4-4-2 2 cyl. simple	20 in. x 26 in. 200 lbs.	130¼ in.	62,800 lbs.	689 lbs.	91 lbs.
Pennsylvania	4-4-2 2 cyl. simple	22 in. x 26 in. 205 lbs.	137½ in.	77,900 lbs.	658 lbs.	118 lbs.
Baltimore & Ohio	4-6-2 2 cyl. simple	24 in. x 32 in. 205 lbs.	104 in.	92,000 lbs.	890 lbs.	103½ lbs.
Assoc. Lines	4-6-2 2 cyl. simple	25 in. x 28 in. 200 lbs.	113½ in.	98,000 lbs.	920 lbs.	106½ lbs.
Assoc. Lines	2-8-2	26 in. x 28 in. 200 lbs.	122½ in.	106,200 lbs.	965 lbs.	110 lbs.
					Average....	105 lbs.

The data on American rods is unlimited and the checking of many rods on this comparative basis gives about the same figure as the average for the six cases chosen.

Any main rod made of open hearth steel (80,000 lbs.) that carries 100 lbs. or more per pound weight of rod can be considered as good practice. This figure is a convenient way to check the design of a rod to see whether it is good practice or not.

Steel for the rods tested as given in Table II was made to the following Baldwin specification:

Blooms made by the open hearth process free from seams, slivers and other surface defects.

To show the following analysis by Baldwin standard method.

Carbon, about.....0.40 per cent. Phosphorus, not over..0.05 per cent.
Manganese, not over..0.60 per cent. Sulphur .....0.05 per cent.

Blooms should be of such quality that a test piece machined cold from a full sized bloom of each heat has, when tested, an ultimate tensile strength of 80,000 lbs. per sq. in., and an elongation of 20 per cent. in a test section originally 2 in. long. Blooms will not be used that show an ultimate strength of less than 75,000 lbs. per sq. in., or more than 90,000 lbs. per sq. in., or an elongation of less than 15 per cent.

CHROME-VANADIUM STEEL WHEELS

Records covering five pairs of carbon and eight pairs of chrome-vanadium solid steel wheels under tenders of Atlantic type locomotives on the Vandalia show that the chrome-vanadium wheels will give about two and a half times as much mileage per unit of wear as the carbon steel wheels. The records cover three and a half years' service and up to the present time the vanadium wheels in these tests have made a mileage of over 300,000 miles and it is reported that they appear to be able to run 400,000 miles before being worn to the limit. The record of mileage for 1-16 in. reduction in diameter due to wear and also to wear and turning is given in the accompanying table:

	Chrome-Vanadium Wheels.	Carbon Steel Wheels.	Per Cent. Difference.
Coal capacity, tender, tons	12	12	...
Water capacity, tender, gallons	7,500	7,500	...
Weight of tender in working order, pounds	143,000	143,000	...
Average load per wheel, pounds	17,875	17,875	...
Average mileage per 1/16 in. diam. wear	12,857	9,259	38
Average mileage per 1/16 in. diam. wear and turning	6,137	2,427	152
Maximum mileage per 1/16 in. diameter wear and turning	6,894	3,344	105
Minimum mileage per 1/16 in. diam. wear and turning	5,536	1,294	327

It will be noted that while the mileage of the vanadium wheels due to wear is about 38 per cent. greater, when the turning is also included it is 152 per cent. greater. This is because the increased flange wear on the carbon wheels necessitated a greater reduction in the diameter to obtain the proper contour.

A pair of chrome vanadium wheels included in these tests, which had then completed 258,000 miles, was exhibited at the last Atlantic City convention by the American Vanadium Company. Following the exhibition this set of wheels was cut up for test purposes and a series of physical and chemical tests were made. The physical tests showed an elastic limit from 89,400 lbs. to 105,450 lbs., with an ultimate strength varying from 132,530 lbs. to 148,000 lbs. The hardness tests showed an average across the cross section of the tread of 45 by the scleroscope.

During the past few years investigations have been conducted to determine the most satisfactory commercial method of heat treating chrome-vanadium wheels. As a result of this work a method of treatment has many advantages from a commercial standpoint, and gives a wheel of uniform physical properties, has been developed. This consists of heating the wheel to a certain temperature and then spinning it with the tread immersed in a trough of water to a little below the limit of wear line, for a predetermined length of time. It is then taken out and allowed to cool in the air after which it is re-heated for annealing. Results obtained from the investigations of wheels treated in this manner indicate that the best wheel should show on the tread and on the face of the wheel a scleroscope hardness of from 40 to 55 which represents an elastic limit across the tread of from 89,000 lbs. to 90,000 lbs. per square in., with an elongation in 2 in. of not less than 12½ per cent. and a reduction of area of not less than 40 per cent. The results of these tests and investigations indicate that a most satisfactory solution of the problem of excessive wheel wear and shelling can be obtained by heat treated vanadium steel.

TRANSMISSION OF ELECTRIC POWER

Flow of Water from Pumps Used to Explain the Various Systems of Electric Distribution

BY L. R. POMEROY.

There are two general systems of electrical distribution—direct current (d. c.) in which the flow is always in one direction and alternating current (a. c.) in which the flow is first in one direction and then in the other.

The direct current system may be divided in two classes: constant current, in which the current remains constant, regardless of the resistance of the circuit, and constant voltage, in which the pressure or voltage remains constant, regardless of the amount of current flowing. A constant current generator may be compared to a plunger pump, from which a constant volume of fluid is displaced, regardless of the resistance in the pipes or the head against which it works; while a constant voltage generator may be likened to a centrifugal fan, which delivers a constant pressure for any flow up to its limit. The constant current system is used extensively in America for arc lighting, where it is common practice to install long series of lamps for street lighting.

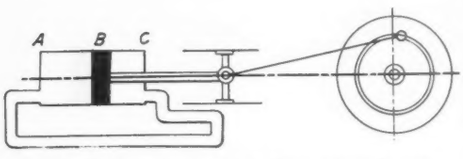


Fig. 1—Pump Giving a Reversing Current.

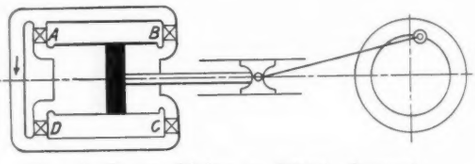


Fig. 3—Pump Giving a Direct Current.

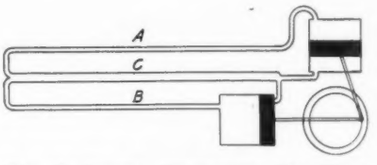


Fig. 5—Pumps Illustrating the Flow from a Two-Phase Generator.

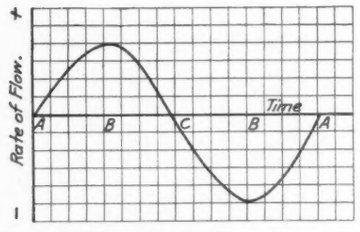


Fig. 2—Diagram of Flow from the Pump Shown Above.

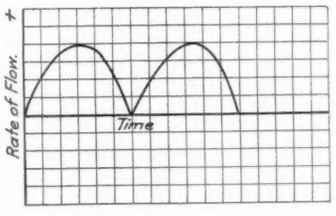


Fig. 4—Diagram of Flow from the Pump Shown Above.

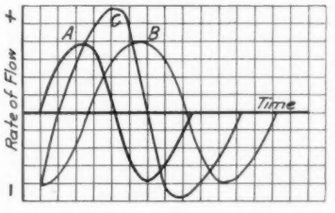


Fig. 6—Diagram of Flow in the Pipes Connected as Shown Above.

It is also used in France and Switzerland for transmitting power over long distances, in which case extremely high pressures are used. The constant pressure system is, however, the one which is employed in the great majority of cases, and it is the one referred to whenever direct current is mentioned, unless it is specifically stated otherwise.

The alternating current system may also be divided into constant current and constant pressure; the latter again into single and multi-phase. The constant current alternating-current system is generally used for arc lighting, but with this exception, all alternating-current working is on the constant pressure system. The single-phase system was installed originally for lighting only, but of late years the advent of the single-phase railway motor has brought it again into prominence for railway work. Single-phase motors of small size are now also made to give satisfactory service for industrial work, but the great majority of alternating-current power work is done on the two or three-phase system.

The operation of all commercial electric machines is based on the fact that when a coil of wire is moved in a magnetic field so that the number of magnetic lines threading through it is changed, a pressure or voltage is set up, and if the ends of the coil are joined, a current flows through it. Conversely, if a current is passed through a coil placed in the magnetic field it will tend to move in such a direction as to increase the number of magnetic lines through the coil. Whenever a coil is rotated in a magnetic field, the magnetic lines pass through it, first in one direction and then in the other. This causes the pressure at the terminals to reverse or alternate in direction, and if a direct or uni-directional current is to be obtained from the generator, some arrangement must be provided for changing or commutating the direction of the current. This device is called a commutator, while the coils which produce the pressure, together with the core upon which they are wound, is the armature. The portion of the machine which produces the magnetic field is termed the field.

An arrangement consisting of a piston and cylinder with a pipe connecting the two ends of the cylinder is shown in Fig. 1. If the piston is moved back and forth, the fluid will be forced through the pipe, first in one direction, then in the other. In other words, there is an alternating current in the pipe. If the crank driving the piston is rotated at a constant speed, the flow through the pipe will be as shown in Fig. 2. When the piston is at *A* its speed is zero, as it moves to the right its speed increases, and reaches a maximum at *B*, then decreases again to zero at *C*. The rate of flow through the pipe corresponds to the velocity of the piston, and, as is well known, follows the sine law. In the same way, the pressure developed by an a. c. generator follows a sine law, and though certain conditions may modify the shape of the wave, the sine form is the one most desired.

A modification of the arrangement shown in Fig. 1 is illustrated in Fig. 3. At both the top and bottom of the cylinder are pipes connecting the two ends, and these two pipes are connected by a third At *A*, *B*, *C* and *D* valves are placed. If, when the piston moves from left to right, valves *B* and *D* are opened, and *A* and *C* closed, then the fluid flows in the connecting pipe as is indicated by the arrow. If, as the direction of the movement of the piston is changed, valves *A* and *C* are opened and *B* and *D* closed, the current will flow through the common pipe in the same direction as before. An arrangement of this kind gives a direct current in the connecting pipe. The function of the valves *A*, *B*, *C* and *D* corresponds to that of the commutator of a direct-current machine.

It is to be expected that if trouble occurred with an arrangement of this kind it would be with the valve gear. Trouble would be especially liable to occur if the apparatus operated at high speed. The analogy holds with reference to a d. c. machine, where the chief source of trouble is the commutator, and although modern machines leave little to be desired so far as commutation is concerned, the commutator is always the part of the machine requiring the greatest amount of attention. Further, it is evident that the greater the pressure in the cylinder the greater the chance of trouble with the valve gear. The same holds true with regard to the commutator, and it has been found from actual practice that a pressure much above 600 volts is difficult to handle on a commutator unless very special precautions are taken, and it is this fact that has limited most of the d. c. systems to about 600 volts.

If there are two cylinders with their pistons displaced 90 deg., as shown in Fig. 5, each piston may drive fluid through a

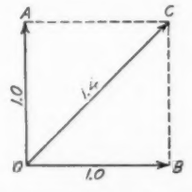


Fig. 7—Diagram Showing Resultant Pressure in Pipe C. Fig. 5.

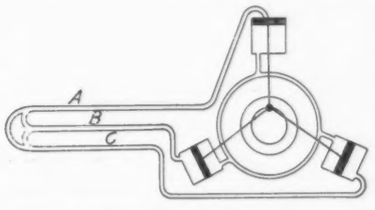


Fig. 8—Pumps Illustrating the Flow from a Three-Phase Generator.

pipe from one end of the cylinder to the other, as is Fig. 1, in which case the rate of flow from one cylinder will be a maximum when that from the other is zero. Fig. 6 represents this graphically, in which curve *A* shows the direction of the flow of the fluid in the pipe *A* of Fig. 5 and curve *B* the flow in pipe *B*.

There may be two pipes from each cylinder, in which case we have what is equivalent to a four-wire, two-phase system, but instead of using four pipes two of them may be combined and replaced by a single larger one as pipe *C* in Fig. 5, and since the maximum rate of flow does not occur at the same time in the two cylinders the common pipe need have only 1.4 times the area of the others. Therefore a saving has been made in the total amount of piping required. If the maximum rate of flow through *A* or *B* is 100 cubic feet a minute, then the maximum rate of flow through *C* is 140 cu. ft. a minute. Similarly, if the maximum pressure between *A* and *C* is 100 lbs. per sq. in., the maximum between *A* and *B* is 140 lbs. In other words, the flow through the common pipe is 1.4 times the flow through either of the single pipes, while the pressure across the outer pipe is 1.4 times that between either outer pipe and the middle one. The value 1.4 may be obtained, as in Fig. 6, by adding the values of the two curves *A* and *B*, in which case the resultant *C* is obtained, and its height will be found to be 1.4 times the height of either of the others. The same result may be obtained by the diagram of forces shown in Fig. 7.

The same conditions hold true for electric working. There are two windings on the armature displaced by 90 deg. A wire may be connected to each end of each winding, in which case we have a two-phase, four-wire system; or the two windings may be connected at one point and three wires brought out, giving a two-phase, three-wire system. The current in the middle wire is 1.4 times the current in either outer wire, while the pressure between the outer wires is 1.4 times that between either outer and the middle.

Three cylinders are shown in Fig. 8 with their pistons displaced by 120 deg. If a pipe is taken from the front and from the rear end of each cylinder, six pipes will be required, and give what is equivalent to a three-phase, six-wire system. It will be found that by taking the three pipes from the inner ends of the cylinders, or the three from the outer ends, the flow outward in two of the pipes will always balance the flow inward in the other pipe. It is therefore possible to combine three of the pipes in one, as is shown at the inner ends of the cylinders in Fig. 8. The flow in the three pipes, *A*, *B*, and *C*, is represented by the curves in Fig. 9, and it will be seen that at any instant the flow in one pipe in one direction is always sufficient to balance the flow in the two remaining pipes, which is in the opposite direction. The arrangement shown in Fig. 8 is equivalent in electrical working to the three-phase, three-wire system. The current in each of the wires is the same as it would be in a three-phase, six-wire system, and the pressures between any two of the three wires are equal, but each of these pressures is equal to 1.73 times the pressure across a single cylinder.* This is due to the fact that the pressures combine at an angle of 60 deg., as is shown in diagrammatic form in Fig. 10.

In a three-phase generator there are three windings on the armature placed 120 degrees apart. The usual arrangement is to join one end of each winding to a common point called the neutral, and to connect the other ends to the three line wires. The currents in the three windings are equal, provided the machine is symmetrically loaded, and the voltage across two windings is equal to 1.73 times the voltage from any terminal to the neutral point.

In a single-phase system, watts equal current (C) times pressure or voltage (E). The two-phase, four-wire system is evidently equal to two single-phase systems, and where the two phases are equally loaded, watts = 2CE. A three-wire, two-phase system is also equivalent to two single-phase systems with a common return wire, and the watts = 2CE, where *C* = current in one outer wire, and *E* = voltage between either outer wire and the middle. The three-phase, six-wire system is equivalent to three single-phase systems, and the watts = 3CE, where *C* and *E* are current and voltage across one phase. A three-phase, three-wire system is equivalent to three single-phase circuits, except that the voltage between any two wires equals 1.73 times the voltage on any one of the three single-phase circuits. The watts therefore equal 3CE, but since $E = E_1 \div 1.73$ where E^1 equals the voltage across any two wires of a three-wire system the watts = $1.73CE^1$; *i. e.*, in a three-phase, three-wire system the

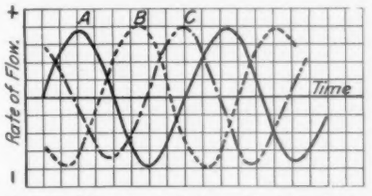


Fig. 9—Diagram of Flow in the Pipes Connected as Shown in Fig. 8.

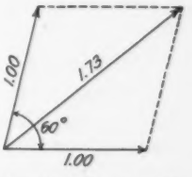


Fig. 10—Method of Obtaining the Pressure Between Either Two of the Pipes A, B or C in Fig. 8.

watts equal 1.73 times the current in one wire times the voltage between two wires. If a two-phase or three-phase system is not symmetrically loaded, it is necessary to find the watts in each phase and then take the sum.

LOSS IN TRANSMISSION.

Assume that 10 k. w. is to be transmitted at 2,000 volts by the following systems: Two-phase, four-wire; two-phase, three-wire; three-phase, three-wire, and that the resistance of each wire equals *R*. What will be the loss in each case?

Two-phase, four-wire.—Since there are two phases each will carry 5 k. w., and the current equals 5,000 ÷ 1,000 or 5 amperes, The loss in each wire will be 5^2 times R or 25R, and the total loss will equal four times this, or 100R.

Two-phase, three-wire.—Each outside wire carries 5 amperes

*This is true if we consider that the pressure in the outer end of the cylinder is equal to that in the inner end, plus the driving pressure.

and the middle wire 1.4 times 5 or 7 amperes. The total loss will be $(2 \times 5^2 \times R) + 7^2 \times R = 99R$.

Three-phase, three-wire.—Since the output in watts of a three-phase, three-wire system = 1.73CE, the current in each wire = watts ÷ 1.73E or 5.78 amperes, and the total loss will equal $3 \times 5.78^2 \times R = 100R$.

From the above it is evident that with the same voltage and losses it is possible to transmit power on the two-phase, three-wire or the three-phase, three-wire system with only three-quarters the amount of copper required for the single-phase, or for the two-phase, four-wire system, or for the direct-current, two-wire system. It should be noted, however, that with the two-phase four-wire system the voltage between the outer wires is 40 per cent. greater than with the three-phase system.

Since the power transmitted is equal to the pressure times the current, it is evident that if the pressure is increased the current is decreased proportionately, and since the loss in transmission varies as the square of the current, it is clear that if the pressure is doubled the loss is only one-fourth as great; or that the same power may be transmitted four times as far with the same loss, provided the same size of wire is used; or that the same amount of power may be transmitted the same distance with the same loss, using only one-fourth the weight of wire. For example, suppose it is desired to transmit 100 k. w., at 1,000 volts single-phase to a distance of one mile over a No. O. B. W. G. copper circuit. The current will be 100 amperes, while the resistance of such a circuit = .95 ohm. The loss in transmission, therefore $= 100^2 \times .95 = 9.5$ k. w. or 9.5 per cent. If the pressure is raised to 2,000 volts, the current will be 50 amperes, and the loss $= 50^2 \times .95 = 2.37$ k. w., or 2.37 per cent.

It is evident, therefore, that we may transmit at 2,000 volts for a distance of four miles over a No. O wire with the same loss as over one mile at 1,000 volts. If the voltage was raised to 10,000 the same amount of power could be transmitted 100 miles over the same size wire with the same loss, or it could be transmitted 10 miles with the same loss and same weight of copper as for one mile at 1,000 volts. This example shows the great economy in transmitting at high voltage. In fact, it is only by using very high voltages that long distance transmission is commercially possible, and even at voltages of 100,000 it is feasible only where large amounts of power are required, on account of the heavy cost of pole lines, insulators, etc.

TRANSFORMERS.

For transmission work, alternating current has one great advantage over direct current, in that it may be stepped up or stepped down by means of transformers to any pressure desired. A transformer consists essentially of an iron core around which two windings, the primary and the secondary, are placed. These are entirely insulated from each other. When an alternating current passes through the primary winding, it produces an alternating magnetic field in the core, which passes through the secondary winding, and as it alternately increases, decreases, reverses, etc., it produces a voltage in the secondary winding. The voltages on the two windings are proportional to the number of turns which each contains. For example, if there are 100 turns in the primary winding and 10,000 in the secondary, and 100 volts is impressed on the primary, the secondary will develop a pressure of 10,000 volts. It is evident that the theory of voltage generation in the secondary of a transformer is the same as in the armature windings of a generator, the difference in method being that in the generator the voltage is produced by varying the magnetic field through the coils by rotating them in a constant magnetic field, while the magnetic field through the secondary coils of a transformer is varied by the varying current through the primary coils.

The transformer is a very simple piece of apparatus. There are no moving parts, the coils are easily wound and insulated, and its efficiency is extremely high, large transformers giving over 98.5 per cent. efficiency at full load. The transformers thus afford a ready method of obtaining high voltages for transmitting, and for lowering such voltages to values suitable for use on commercial machines. It is almost needless to say that while the pressure varies directly as the number of turns, the current varies inversely as the turns, so that except for losses in the transformer, the current times the pressure in one winding equals the current times the pressure in the others.

Quite often it is desired to transmit alternating current, and to distribute direct current for motors, lighting, etc. In such cases an alternating-current motor connected to a direct-current generator may be used. There is, however, another machine more efficient and cheaper than the motor generator set which is extensively used for this purpose. This is called a rotary converter, and is the combination of an alternating-current motor and a direct-current generator in a single machine.

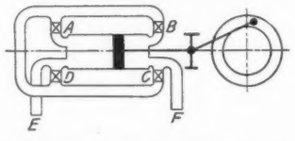


Fig. 11—Pump with Connections to Illustrate Action of a Rotary Convertor.

The hydraulic analogy for a direct-current generator as given in Fig. 3, is reproduced in Fig. 11, with the addition of a pipe at each end of the cylinder. These pipes, *E* and *F*, are used to bring in fluid under alternating pressure, which is transformed to direct pressure in the cylinder. When fluid flows in at *E* the piston moves from left to right, with valves *B* and *D* closed and *A* and *C* opened, and current will flow through the main pipe as indicated by the arrow. If, when the end of the stroke is reached, valves *A* and *C* are closed and *B* and *D* opened, then as the current flows in at *F* the piston will move from right to left, and the flow in the main pipe will be in the same direction as before. Thus the alternating flow has been changed to a direct flow. In this case the piston does little more than operate the valves *A, B, C* and *D*, and the capacity of the cylinder is supposed to be very small as compared to the total amount of fluid flowing. The same conditions apply to a rotary converter. The alternating current flowing through the armature is changed by the commutator into direct current. It will be noted that the piston must move synchronously with the alternating current flow. The same applies to the rotary, which runs as a synchronous motor. If a direct current be supplied to the cylinder through the proper valves, alternating current will be delivered through the pipes *E* and *F*. The same facts apply to the operation of a rotary converter, and if it is supplied with direct current it will deliver alternating current.

It is evident also that if the outlet valves are partially closed, there may be a heavy pressure upon the piston, which is then capable of doing outside mechanical work. The same thing applies to a rotary converter. It may run as a synchronous motor and do mechanical work; it may run as a rotary converter without doing mechanical work; or it may run as a combination motor and converter, transforming from alternating to direct current, or vice versa, and at the same time do outside work.

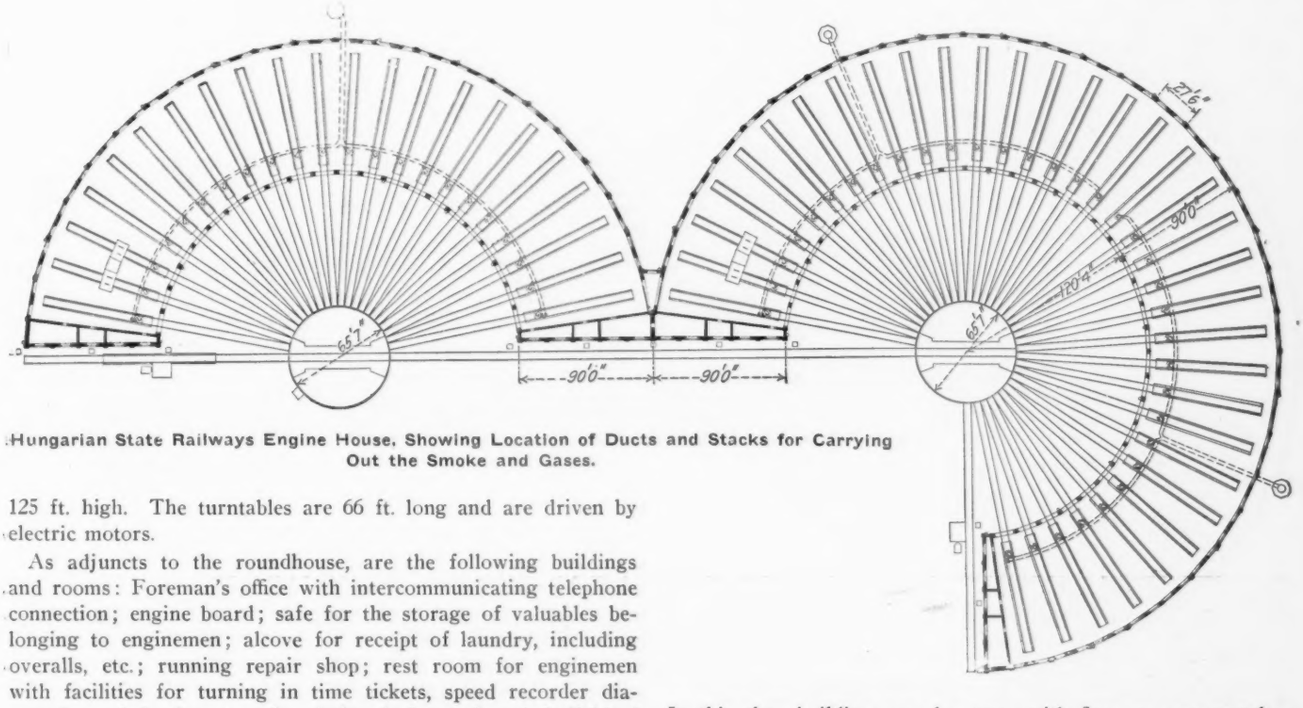
In a three-phase rotary converter the alternating-current voltage is approximately 60 per cent. of the direct-current voltage, and in a two-phase or six-phase converter it is approximately 70 per cent. of the direct-current voltage. It is, therefore, necessary to install transformers for stepping down from the alternating-current supply voltage to such a value as to give the proper direct-current voltage. Since the ratio of alternating current to direct-current voltage is fixed within comparatively narrow limits, the direct-current voltage cannot be varied over a wide range unless some special regulating device is used. There are several devices for this purpose.

SUPERIOR EUROPEAN ROUNDHOUSE FACILITIES

As Seen on the Hungarian State Railways and in France, with Suggestions as to American Practice

BY HENRY W. JACOBS.

The engine house about to be described is at Budapest, Hungary, and consists of two roundhouses, one a half circle with 22 pits, the other a three-quarter circle with 34 pits. These are the most up-to-date roundhouses that it has been my good fortune to visit, and, therefore, merit special attention. They are built of brick and stone, with steel roofs, and a double swinging door to each stall. Both buildings are equipped with the Fabel central smoke uptake. The engines are backed into the stalls, tender first, and over the small diameter circle above their stacks is a large rectangular duct into which the smoke jacks carry the fumes from the locomotive stacks. One hundred and twenty degrees apart are ducts that lead from this inner circular duct to the outer wall where they are connected with a tall brick stack. In this way a good draft is secured that takes every vestige of smoke out of the roundhouse, leaving a clear atmosphere. I have never seen such a thoroughly successful method of ventilating a roundhouse. The chimneys are about



Hungarian State Railways Engine House, Showing Location of Ducts and Stacks for Carrying Out the Smoke and Gases.

125 ft. high. The turntables are 66 ft. long and are driven by electric motors.

As adjuncts to the roundhouse, are the following buildings and rooms: Foreman's office with intercommunicating telephone connection; engine board; safe for the storage of valuables belonging to enginemen; alcove for receipt of laundry, including overalls, etc.; running repair shop; rest room for enginemen with facilities for turning in time tickets, speed recorder diagrams, work books, etc.; the clothes lockers of each individual engineer are in the roundhouse proper; rest room for firemen and hostlers, heated by gas and fitted with clothes lockers for each individual man; room for the care of oil cans, each individual engineer having his own cans and allotted shelf; room for care of engine lamps; room for roundhouse machinists; room for air brake instruction; room for foreman of the electrical equipment; carpenter's shop; electric transformer room; and rooms containing gas hot water preheaters for outgoing locomotives.

A word should be said as to the care of the oil, oil cans, lamps and supplies for locomotives. These articles are assigned to the individual engineers so that notwithstanding the locomotive pooling system, the men retain their individual equipment of supplies and tools, and have an interest in their economical use.

For boiler washing the Schilhan Wittenberg hot water system is installed, which utilizes the steam from incoming engines for heating the water. In the roundhouse is an electrically operated drop pit, using a 9 h. p. motor, which is kept in scrupulously clean condition. There are separate office buildings for the chief roundhouse foreman and the assistants and clerks attached to him; in this office building is, as in each of the shops, a small emergency surgical operating room.

In the air brake instruction room are facilities for instruction in the use of the brakes, as well as in the use of lubricators, first aid to the injured, high tension electric apparatus, different locomotive valve gear, signals, etc. On the walls are charts and tables illustrating these.

Attached to the roundhouse is a small shop with four pits for light locomotive repairs, and the necessary machine shop equipment for carrying on these repairs. A jib crane of five tons capacity serves to hoist heavy parts to their respective machines.

In this shop building are also two smith fires, an oxy-acetylene welding outfit, pipe and coppersmith benches and fires, together with a babbitt furnace, etc. Attached also to the roundhouse is a complete store building with equipment for handling oils without waste, and for the safe storage and easy handling of new and scrap materials.

A provision that was made for the personnel was most surprising; namely, an auto bus service consisting of two auto buses that made regular scheduled trips to outlying residence districts to take the enginemen to and from their runs. A garage, with a room for the chauffeurs of these auto buses, was also provided.

Another small building contained twelve compartments for engineers and firemen, with individual beds, besides six bath rooms, four showers, two wash rooms and two dining rooms with heating facilities for the lunches that the men might bring

with them. Great importance was attached to absolute cleanliness and quiet in these lodging quarters. A lunch room where light refreshments and coffee could be purchased, and accommodating about 100 men at one sitting, was also provided.

A sand drying and storage house formed a part of the plant, together with ash pits permitting the cleaning of the fires of ten locomotives at the same time, with ten water cranes constituted so that water could be taken without moving the locomotives.

In connection with the coaling plant, where the coal was unloaded from the cars first onto the ground, thence to tram cars which were carried by elevator to a concrete platform, where they were dumped direct in the tenders, was an electrically driven circular saw for sawing scrap wood into convenient lengths for firing up locomotives. There was also a mechanical coal sorting device used to determine the quality of the coal received. An inspector would select arbitrarily certain cars of coal, dump these into the machine, which sorted the coal out and determined the proportion of each size, the chemical and heat unit analysis being made from samples of each size; the coal is purchased on the basis of certain specifications.

A conspicuous feature of the roundhouse was the water tower, which had a capacity of 35,000 cu. ft. The bottom of this tank was over 90 ft. above the level of the track, the top level of the water being over 120 ft. above it. The space in the enclosed brick portion underneath the tank served for certain stores.

The accompanying photographs describe better than words the general excellence of the arrangement of this roundhouse, which, as stated before, is the most improved and completely equipped one I have ever seen.

Below are statistics as to the locomotive performance for the 3,500 locomotives of the Hungarian State Lines, for the year 1911:

Total coal consumption for the year	3,580,000 tons
Thousand ton-miles run	20,300,000 tons
Price per ton of coal	$1.48
Coal consumed per thousand ton-miles	350 lbs.
Cost per thousand ton-miles	$0.27
Average locomotive miles run per year:	
1st Class engines	27,000
2nd Class engines	23,000

Another modern European roundhouse is in France. One of the most important division points on the Eastern Railway of France is at Mohon, and complete facilities have been provided for the proper terminal maintenance of locomotives. The arrangement provides for two connecting engine houses of 32 stalls each and a moderate size repair shop, together with coaling stations, etc. The most interesting feature of the terminal is the elaborate design of the engine house. As will be seen by reference to the illustration, which is taken from the *Revue Generale des Chemins de Fer*, the track arrangement is the same as is employed in this country, and provides a 75-ft. turntable. The turntable pit and the inner circle of the house are com-

Engine House Water Tank 140 Feet High and Having 260,000 Gals. Capacity; Hungarian State Railways.

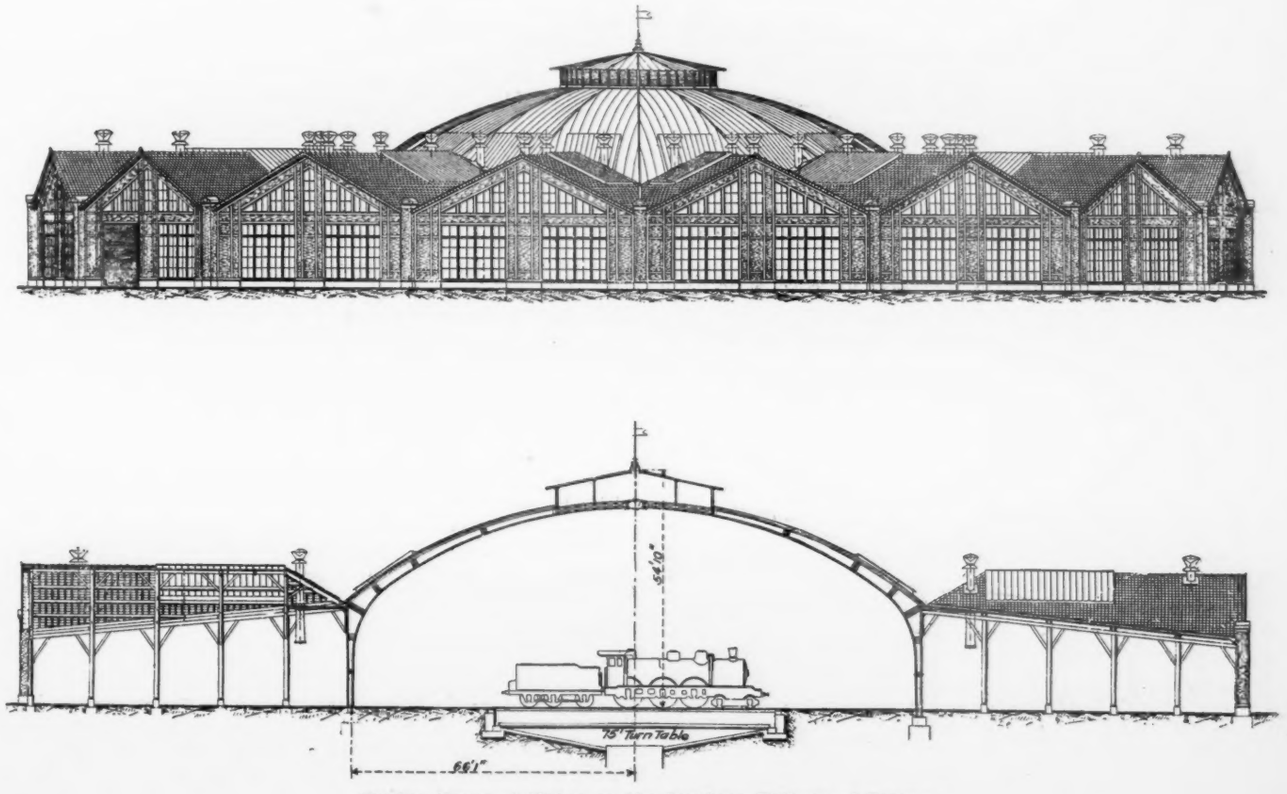
Locomotives face toward the center, and the smoke jacks carry the smoke and gases through the ducts to two high stacks outside, as shown on the drawing.

Interior of Engine House at Budapest on Hungarian State Railways.

pletely covered by a large dome having a clear span of about 132 ft. 2 in. This has a large ventilator in the center and a series of skylights near the bottom of the arch. Surrounding this is a series of what practically corresponds to separate gabled roofed structures, arranged radially, each of which covers two pits. The roof beams are supported by a series of four posts and the outer brick pilasters; this part of the structure is of wood except for the outer wall, which is of brick. The central arch is steel, covered with a zinc roofing.

The smoke jack arrangement indicates that the locomotives are stored with the tenders outward. On each side of the gables are large skylights and the outside wall is about two-thirds glass; it is evident from the illustration that the lighting will be entirely satisfactory if the glass is kept clean. In the top of each gable are large ventilators. Each of these engine houses is about 275 ft. inside diameter and the pits are 65 ft. in length. The distance from the outside wall to the steel columns supporting the dome is 71 ft. The dome is 54 ft. 10 in. high to the top of the ventilator in the center.

While the descriptions of European roundhouses may be of



Engine House at Mohon on the Southern Railway of France.

interest, the practical American will ask how far these principles would benefit our conditions here. I believe the benefits may be very substantial, very practical, and not unduly costly. The present plan of roundhouse construction followed in this country possesses a number of highly objectionable features, some of which are outlined below together with suggestions for remedying them.

The difficulty experienced in properly heating a roundhouse in winter is in a large measure due to the inability to keep closed the numerous large and unwieldy doors necessitated by the type of construction employed. On some of the northern roads like the Grand Trunk Pacific, special types of quick closing doors have been introduced. This difficulty has also been overcome on some European roads by the simple expedient of roofing over the central area, as shown in the accompanying perspective drawing, thereby avoiding the expense and trouble of a door for each engine stall. The only doors necessary in this case are those at the entrance in the outer walls, which may be kept closed with much less difficulty. The roofed over central area may still further be made use of by paving the space between the tracks leading to the stalls and so making it available for trucking purposes.

Further, by covering the turntable pit with a floor attached to and revolving with the turntable, much time may be saved in trucking from one part of the roundhouse to another, because it would then be possible to take the shortest route over the pavement between the track and the covered turntable pit instead of being obliged to follow around the outer wall of the roundhouse, as is now the case.

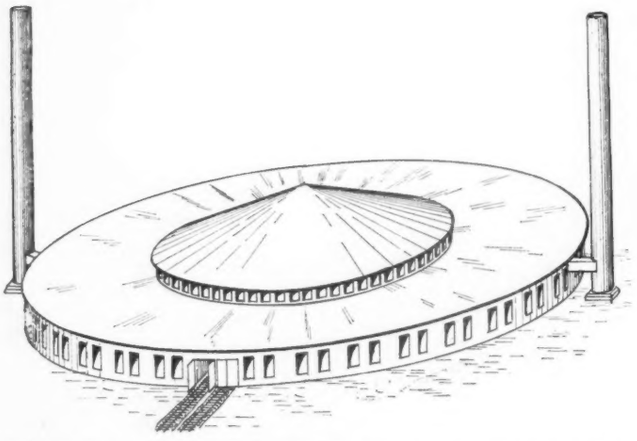
The covered turntable pit would furthermore make it impossible for anything to fall into the pit and consequently prevent many accidents to the employees and to the turntable itself, with the resulting delays in getting engines into and out of the roundhouse.

Carrying this plan a step further, it should be practicable to enlarge the turntable pit until it had a diameter co-equal with that of the circle bounding the inner ends of the stalls. This would require a turntable some 150 ft. or over in length, the construction of which should involve no serious difficulty. Such a turntable could be supported on several concentric rails and could also be so jointed and equalized as to allow of taking up slight inequalities of vertical movement due to the rails not being exactly level at all spots. But in turning, the engine would be balanced at the middle of the table as now, the main weight being borne by the center pivot. This pit might be very shallow, say 12 or 18 in. The girders supporting the turning locomotive, if raised above the floor level, should allow ample clearance so no men could be caught between them and the locomotive.

By then covering this whole central area with a revolving floor (and doing away with the radial tracks, except in the stalls themselves), certain light machines and benches, clothes lockers, offices and other roundhouse appurtenances taking up room but

not involving heavy weights, could be carried on this great central table, thus utilizing fully the entire investment in ground space and in roof. At the same time much greater convenience would result in the roundhouse handling and repair work.

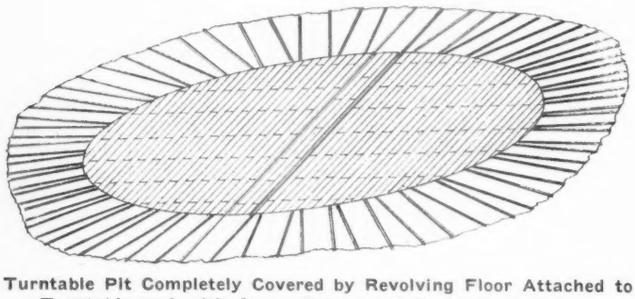
The smoke jacks commonly provided for smoke removal have proved themselves very inadequate and the atmosphere of the roundhouse is usually heavily charged with smoke, soot and gases, making a disagreeable and unhealthful environment for the workmen. This smoke filled atmosphere shuts off the light from the stalls, which condition is aggravated by the deposits of soot and grime on the windows, reducing the amount of light



Roundhouse with Roof over Central Area and Engine Stalls Connected to High Stacks by Circumferential Smoke Ducts.

admitted, which is still further decreased by being absorbed by the smoke blackened walls and roof. Under such conditions it is impossible for the workmen to attain their highest efficiency, especially in winter when the numerous doors make it impossible to keep the temperature in a roundhouse comfortable.

We have referred to the European practice of removing the obnoxious gases and smoke by installing overhead circumferential smoke ducts or canals which are connected to tall chimneys located outside of the building. These ducts are provided with openings and hoods at each engine stall under which the stacks of the engines are placed. The strong draft induced by the



Turntable Pit Completely Covered by Revolving Floor Attached to Turntable and with Space Between Rails in Central Area Paved to the Level of the Tops of the Rails.

tall chimneys carries away every vestige of the products of combustion discharged from the locomotive stacks and leaves the atmosphere of the building clear and well ventilated.

If a steel stack were used instead of one of brick, and possibly a central support were adopted in connection with the turntable, a single stack at the center of the dome might economically take the place of the two or three commonly used in Europe for this purpose.

Some mention should be made of the European practice of placing the locomotives in the stalls with their stacks toward the turntable. With the covered center and with adequate roof lighting, this should cause no difficulty in doing work on cylinders, valves, front ends, superheaters and flues, and should facilitate the handling of material. This plan should also make simpler the installation of a crane for handling cylinders, bushings, cylinder heads, valve chests, pistons, rods, etc.; in fact, the large revolving floor could be used as such a crane carrying heavy material around to that part of the roundhouse near the machine shop or smith fires. An advantage of this proposed construction of central roof and revolving floor, is that it may be readily applied at a moderate expense to almost any existing roundhouse.

Lastly it may be observed that in many engine terminal layouts in this country and in Europe, there is a tendency to build too substantially, too permanently, too well, with brick and concrete, costly coaling stations, ash pits, and other structures. In five years, or in ten or fifteen, transportation conditions may so change that the facilities will also require extensive changes. Therefore, engine houses and their appurtenances should be so designed and built that they are temporary and removable in their nature, so that changes in terminal track location, in engine handling movement, in extension of stalls, even in removing completely the engine terminal to a new location, or in moving a division terminal, may be made with the least expense and the least loss in abandoned facilities.

EFFECT OF PIGMENTS ON THE CONSTANTS OF LINSEED OIL.*

BY HENRY A. GARDNER,
Assistant Director, The Institute of Industrial Research, Washington, D. C.

When sealed packages of paints of the cheaper grades are opened after having been stored for a considerable length of time, there is occasionally observed a degree of hardness that renders application difficult. The user is generally at a loss to account for such a condition, inasmuch as the modern metal container is air-tight and has but little room for improvement. The cause of the hardening that has taken place may therefore be assumed to result from certain reactions between the different constituents of the paint.

Nearly two years ago the writer carefully prepared a series of paints from various well-known pigments, using as a grinding medium a standard vehicle of pure linseed oil containing neither drier nor thinner of any type. The amount of oil used with each pigment was sufficient to bring the paints in every case to a relative viscosity or body, which was somewhat heavier than is ordinarily used in the application of paints to wooden or metal surfaces. These paints, after preparation, were carefully placed in friction-top tin containers. They were moved about occasionally and were subjected to shipment by freight on two occasions, finally remaining on a shelf in the writer's laboratory for nearly a year previous to examination. Upon removing the lids from the cans there was evidenced, by the appearance of some of the paints, a considerable change of a chemical nature. The paints were placed individually in two-quart glass jars with a large quantity of a solvent mixture made of 90 deg. benzol and 86 deg. petroleum ether. After the pigment content of the paint had settled out by gravity, the solvent containing the oil in solution was removed by a syphon and subjected to distillation. The temperature of distillation was kept at a point sufficiently high to remove the low boiling point solvent, but not high enough to affect the oil residue. The usual method of oil examination was then followed, many of the determinations being made in duplicate. The results of these tests are given in the accompanying table.

These results show that inert pigments such as barytes, iron oxide, graphite and carbon black do not enter into chemical action with linseed oil; the percentage of ash found in the oil extracted from the above pigments being practically identical

*Taken from the Journal of The Franklin Institute, October, 1912.

with the percentage shown by the raw oil. That such pigments may, however, have some physical action upon the oil, that will later develop a chemical change therein, seems evident. The thickened condition of the oil extracted from the silica paint, and the low iodine values and high acid values shown by all of the oils extracted from the above-mentioned inert pigments, would give credence to the above statement.

The pigment that is ordinarily termed American vermilion, the true form of which is a basic chromate of lead, seems to have had no very marked effect upon the oil in which it was ground. It would seem, therefore, that it would prove quite practical to transport this pigment in paste form. On account of its value as a protective of metal, it will probably replace, to some extent, the use of red lead for priming steel. The pigment red lead had a marked hydrolyzing reaction on the oil in which it was ground. The latter contained a very large percentage of lead linoleate, free fatty acid, and glycerin. The iodine number of this oil was lower than that of any other extracted.

Zinc oxide and zinc lead had but slight action with the oil, while basic carbonate-white lead showed somewhat greater action, but not sufficient to be of any detriment. With paints containing mixtures of lead and zinc pigments only slight action was shown. The perfect condition of these paints indicates that being so hard that a knife was required to make any impression upon its solidified surface. These paints, moreover, contained pigments of a basic nature, containing a very high percentage of lead and zinc. An examination of the oil in which these paints were ground showed acid values ranging from 8 to 16. That the reaction of the free acid upon the pigments was the real cause of the hardening of the paint was the writer's conclusion. A series of tests were therefore made, in which was included the treatment of paints with small percentages of free oleic acid, one of the most prominent constituents found in oils of a high acid value. There were also included tests in which paints were treated with sulphites, there existing in the paint industry a false belief that lead and zinc pigments are apt to body and harden in oil if they contain even traces of sulphur dioxide or sulphites. Those who have held such a belief should some time examine paints made of sublimed blue lead, a pigment which contains nearly 5 per cent. of metallic sulphites and sulphides. This pigment will remain as a smooth paste in oils for months without any apparent hardening.

Small quantities of dry zinc and lead pigments (basic carbonate-white lead, basic sulphate-white lead, zinc oxide, and zinc lead) were ground in a pure raw linseed oil having a normal acid value of approximately 2.8. After standing for three days,

RESULTS OF EXAMINATION OF OILS EXTRACTED FROM PAINTS.

Pigment.	Analysis— Specific gravity.	Ash (per cent.)	Iodine No.	Acid value.	Condition on opening.
Analysis of original oil	0.932	0.190	181	2.5	
Zinc oxide	0.9237	0.36	161	3.5	Paint in excellent condition. Light colored oil floating on top. Contained fine white zinc of a colloidal nature after extraction with solvent.
Corroded white lead (basic carbonate—white lead)	0.9372	1.149	157.5	8.6	Paint had thick, wrinkled skin on top but was in very fair condition. Oil, after extraction, was light colored and clear.
Leaded zinc	0.9389	0.922	157.4	5.7	Paint in very good condition. Considerable oil floating on top. Oil, after extraction, was somewhat cloudy, but cleared after 24 hours.
50 per cent. corroded white lead (as above) 40 per cent. zinc oxide 10 per cent. barytes	.....	0.674	154.1	6.7	Paint in excellent condition. Some oil floating on top.
60 per cent. sublimed white lead (basic sulphate—white lead) 40 per cent. zinc oxide	0.9334	0.626	157.8	5.6	Paint in excellent condition. Some oil floating on top.
Barytes (barium sulphate)	0.9325	0.212	160.6	3.5	Paint settled to a considerable extent. Much clear oil floating on top.
Silica	0.9465	0.204	149.2	8.7	Heavy, viscous oil, resembling a varnish, was floating on a partly-settled mass of pigment. Oil retained finely-divided pigment in suspension.
American vermilion (basic chromate of lead)	0.939	1.271	156.7	8.3	Pigment settled very hard. Oil, after extraction, was dark, but clear.
Red lead	.....	15.56	135.4	19.2	Pigment settled very hard. A thick, gelatinous oil floated on top of pigment. Oil, after extraction, was dark brown in color.
Iron oxide	0.9457	0.456	156.3	8.6	In excellent condition. Very soft, smooth paste. Oil—clear dark red after extraction.
Carbon black	0.9356	0.195	163	10.5	Thin, wrinkled skin on surface. Paste below skin, very soft and smooth. Oil—clear light color after extraction.
Graphite	.....	0.201	158.5	13.3	Very soft and smooth paste. Oil—clear and light, after extraction.

any properly-prepared combination pigment paint may be safely stored in cans for long periods without bad effects, provided the oil used is of normal grade.

The most astounding change shown in the tests was that in the iodine values of the oils extracted from all of the paints. It would appear, therefore, that when paints are stored for a considerable period of time and then examined for the iodine value of their oil content a lowering of the iodine value should not constitute cause for rejection or be sufficient evidence to state that the oil was adulterated with oils of lower iodine value. Cognizance of this statement should be given by railroads and corporations which have adopted specifications for oil paints.

When hydrolysis has taken place in a paint, considerable thickening is observed. In the tests which are charted above it will be observed that the most extravagant example of hydrolysis was shown by the red lead paint. The oil from this paint showed over 15 per cent. of inorganic lead compounds in the ash. It will also be noticed that the oil had become very acid in nature and had the appearance of a thick jelly, which may be accounted for by the large percentage of glycerin present. Although the red lead paint was very thick, difficult to break up, and too heavy for brushing, it was not really hard. The writer has had occasion, however, to examine several samples of paint recently which were very much harder than the red lead, one, in fact, no tendency toward hardening was shown by any of the paints. They were then divided into small portions, and to each type were added various materials which were under suspicion as having, when used, some contributing effect in the hardening of paint. The following table shows the results of these experiments:

Treatment with 20 per cent. gloss oil (½ rosin, ½ benzine)	Considerable hardening shown in 24 hours, indicating action between the acid rosin (resinic acids) and the basic pigments.
Treatment with 2 per cent. sodium hyposulphite	No effect noticed in 6 days.
Treatment with 5 per cent. oleic acid	Hardening occurred in two hours and increased with age. Paint resembled hard putty.

From these results it is apparent that oils of an acid nature are the most active cause of paint hardening. The use in cheaper paints of substitutes for linseed oil, which contain large percentages of rosin, as well as the promiscuous use of acid rosin driers, has been the cause of the hardening of many paints. Linseed oil containing high percentages of acid is, of course, dangerous. It is evident, therefore, that a careful consideration of the vehicle portion of a paint is even more important than the pigment part, and a careful record of the acidity of paint oils should be kept by the grinder.

The author wishes to acknowledge the assistance of Messrs. L. G. Carmick and J. E. Heckel in the analytical determinations.

STANDARDIZATION OF THE MYRIAWATT*

At a joint meeting of the American Society of Mechanical Engineers' Special Committee on Myriawatt, with the Standards Committee of the American Institute of Electrical Engineers, in December, it was decided to recommend to both societies that the "Myriawatt" be used as a unit of thermal and mechanical power. This has been done to introduce a new unit of power which will afford a basis of comparison of all converters of energy, thermal or mechanical. It will be international in its use, and is merely a new multiple of the watt, the word being taken from the Greek word "myria," meaning 10,000. With this unit, and the British thermal unit taken as 1/180 of the heat required to raise one pound of water from 32 deg. Fahr. to 212 deg. Fahr., and the equivalent evaporation from 212 deg. Fahr. as 970.4 B. t. u., which is taken from the Marks & Davis steam tables, we have the following equivalents, the myriawatt being designated as mw and the myriawatt-hour as mw-hr:

1 B. t. u..... = 0.00002928 mw-hr.
1 foot-pound ..... = 0.000000037662 mw-hr.
1 horse power..... = 0.07457 mw
1 kilowatt ..... = 0.10000 mw
1 boiler horse power. = 0.9804 mw

The value of one myriawatt will be:

1 mw ..... = 34150 B. t. u. per hr.
1 mw ..... = 26,552,000 ft.-lbs. per hr.
1 mw ..... = 13,410 h. p.
1 mw ..... = 10 k. w.
1 mw ..... = 1.020 boiler horse power

It is stated in the report to the American Institute of Electrical Engineers that since the present standard of one boiler horse power is equivalent to 33,479 B. t. u. per hour, and that a myriawatt is equivalent to 34,150 B. t. u. per hour, the ordinary method of determining the boiler capacity could be stretched 2 per cent., the difference between the two values, without materially affecting the present rating, and in this way entirely eliminating the term "boiler horse power," using the myriawatt in its stead.

BALTIC TYPE LOCOMOTIVE

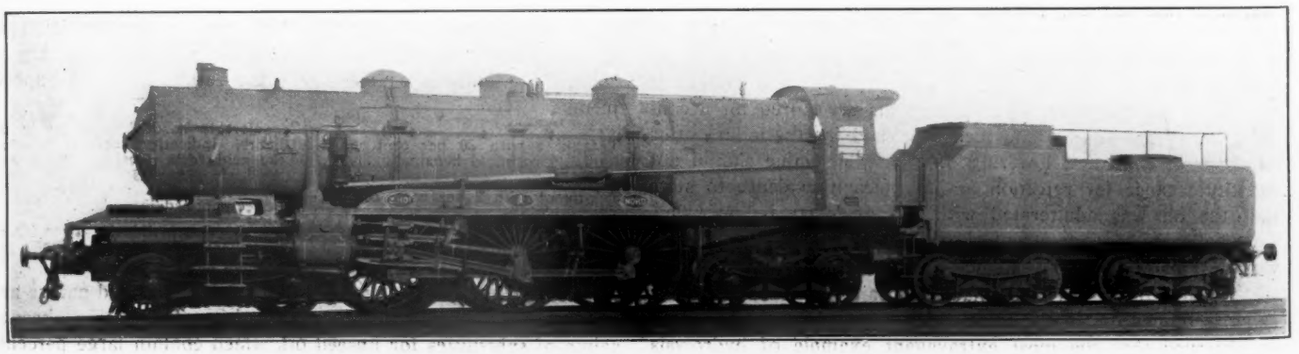
The largest passenger locomotives in Europe were built during the past year for the Chemin de Fer du Nord, and are operating the Nord Express between Paris and Brussels. This train has a reputation of maintaining the fastest schedule in the world. The engines were designed to handle a 400-ton train behind the tender at a speed of 75 miles an hour on the level and 60 miles an hour on .5 per cent. grades.

These locomotives, of the 4-6-4 type, were designed and built under the direction of M. Asselin, chief engineer of motive power and rolling stock, the one illustrated being constructed at the company's shops in Paris. They are of the four-cylinder, balanced compound type, the low pressure cylinders being between the frames, and drive through a cranked axle on the front pair of drivers. Because of the size of the inside cylinders it was not possible to place them side by side between the frames and they are therefore staggered. The main rods are of the same length, however, and the cylinder furthest ahead has a very long piston rod. Highly superheated steam is employed and the high pressure cylinders, which are about 17½ in. in diameter with a 25¼ in. stroke, have piston valves, while the low pressure cylinders, which are about 24⅜ in. in diameter, with a 28¾ in. stroke, have slide valves. Each valve has an independent Walschaert valve gear.

The boiler is unusually large when compared with other European locomotives. It is about 68 in. in diameter at the front ring, of the straight top type with a Belpaire firebox on one locomotive and a water tube firebox on the other. In the Belpaire boiler there are 131 tubes; 34 of them are 2⅛ in. in diameter, and 97 are 2½ in. in diameter. There are also 27 superheater flues 5¼ in. in diameter. The tubes are about 23 ft. 7¼ in. in length between tube sheets and give a total heating surface of 3,190 sq. ft. The Belpaire firebox has a heating surface of 206 sq. ft., giving 3,396 sq. ft. total heating surface in the boiler. The grate area is 46.1 sq. ft. In the water tube firebox are 623 tubes, giving a heating surface of 1,280 sq. ft. The front end of the boiler is very long, measuring 10 ft. 6 in. from the tube sheet to the front ring. The superheater is of the Schmidt type, and the steam is carried through an outside pipe to the top of the high pressure steam chest.

The arrangement of the front and rear trucks is much alike and the equalization system of the drivers does not include either cross equalizers or a connection to the trucks at either end. The customary style of plate frame is employed and the springs are located above the driving boxes for the first and second pair of drivers and below at the third. The weight on the rear trucks is transferred from the frame through semi-elliptic springs secured to the outside of the locomotive frames and resting on the ends of the truck bolsters. The general dimensions of the locomotive with the Belpaire boiler are given below:

Tractive effort, compound	32,362 lbs.
Weight on drivers	119,000 lbs.
Weight on front truck	53,000 lbs.
Weight on trailer	53,000 lbs.
Weight, total engine	225,000 lbs.
Wheel base, driving	14 ft. 1 in.
Wheel base, total engine	41 ft. 3 in.
Cylinders, diameter	17½ in. and 24⅜ in.
Cylinders, stroke	25¼ in. and 28¾ in.
Driving wheels, diameter	80 in.
Steam pressure	227 lbs.
Boiler, inside diameter at front ring	68 in.
Tubes, number and diameter	34—2⅛ in.; 97—2½ in.
Flues, number and diameter	27—5¼ in.
Tubes and flues, length	23 ft. 7¼ in.
Heating surface, tubes and flues	3,190 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	3,396 sq. ft.
Heating surface, superheater	753 sq. ft.
Grate area	46.1 sq. ft.



Largest Passenger Locomotive in Europe; Northern Railway of France.

*Taken from the February Journal of the American Society of Mechanical Engineers.

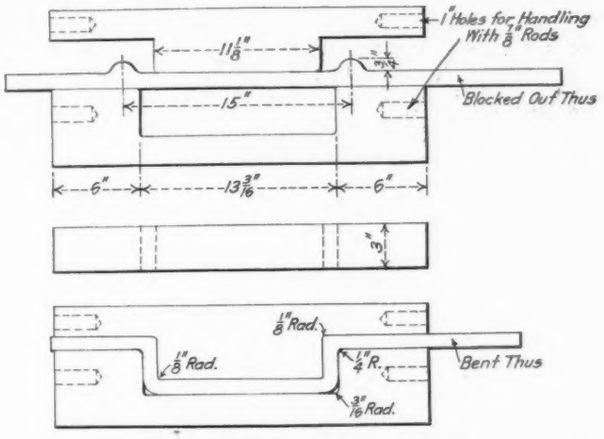
SHOP PRACTICE

SMITH SHOP TOOLS

BY J. F. PERRITT,
Foreman Blacksmith, Seaboard Air Line, Jacksonville, Fla.

BENDING CARRY IRONS.

This tool was designed for bending carry irons under a steam hammer. The illustration shows clearly the method of operation; it has been in successful use for a considerable time. The

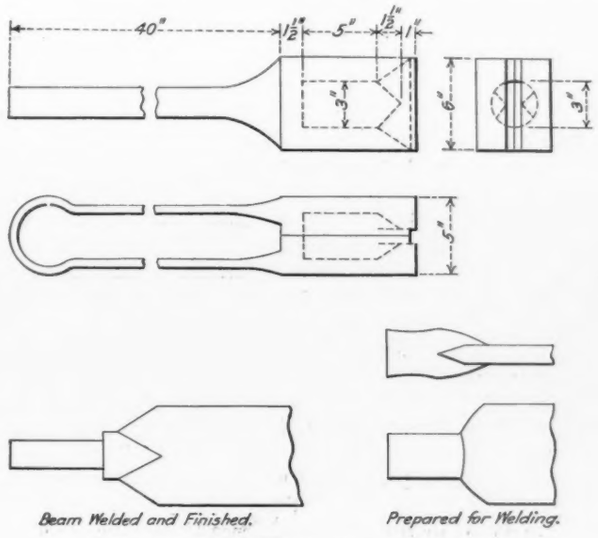


Operation of Bending Carry Irons.

dimensions may, of course, be varied to suit any special requirements.

REPAIRING LOCOMOTIVE BRAKE BEAMS.

This device is for use in making and repairing under a hammer locomotive, brake beams that have become badly worn on the ends. The end of the beam is scarfed and the new end made with a V-shaped notch to fit over the beam. The welding heat

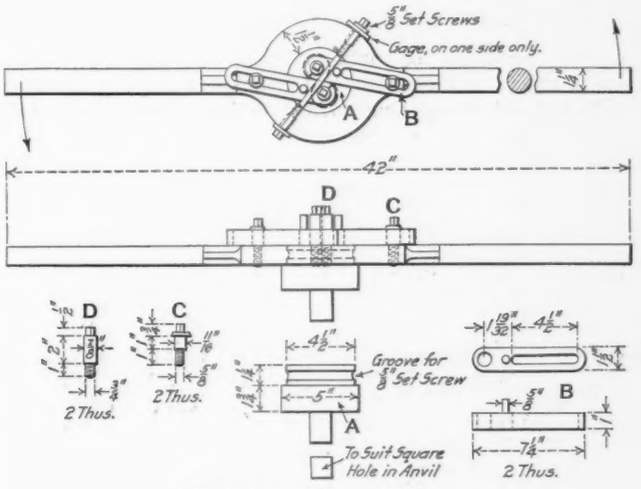


Tool for Repairing Locomotive Brake Beams.

is then taken and the weld is made in the tool under a hammer. We have used this device a great deal and find that in addition to saving time and material it enables the smith to do a neat job with but little effort.

BENDING S-HOOKS.

In bending S-hooks with this device, the body *A* is placed on the anvil and supports the tool. The slotted links *B* are held by the two studs *D* and slide on the two studs *C*. The metal is placed between the pins shown on the sliding links, as indi-



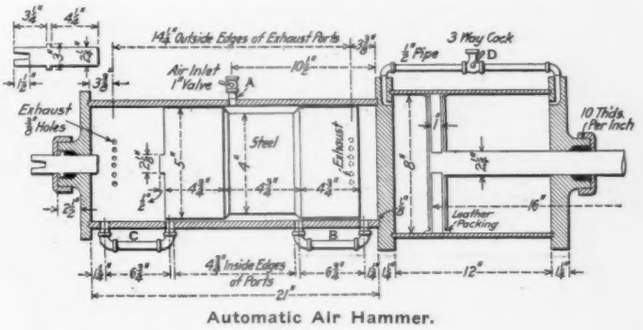
Device for Bending S-Hooks.

cated by the heavy, straight lines, and by turning the handle in the direction of the arrows the hook is formed as shown by the curved dotted lines.

PNEUMATIC HAMMER FOR BOILER SHOPS

BY J. C. BREKENFELD,
Assistant Machine Shop Foreman, St. Louis & San Francisco, Springfield, Mo.

The hammer shown in the drawing has proved efficient as a staybolt breaker and a riveter, as well as for general use. It has been in severe service for some years, and consists of a cylinder 5 in. inside diameter, in which is contained a floating piston. The air enters the cylinder at *A*, fills the annular space at the center of the piston and passes back of the pis-



Automatic Air Hammer.

ton through the connection *B*, driving it forward. A 2⅛ in. x ½ in. projection is provided on the end of the piston for striking the hammer. The exhaust ports consist of six ⅜ in. holes bored in the cylinder 3⅜ in. from each end. These holes are covered when the piston is at the extreme ends of the cylinder. When the piston is in the forward position, the air is allowed to pass through the pipe *C*, the connection *B* being

closed to the air pressure. The piston is thus driven to the rear, but is prevented from striking the rear head by the air cushion. At the rear part of the apparatus is a cylinder 8 in. in diameter which contains a piston and piston rod, and is used to brace the hammer and hold it against the work, the air pressure being supplied through the three-way cock *D*.

TURNING FOUR-BAR CROSSHEAD WRIST PINS

BY H. T. NOWELL,
General Foreman, Boston & Maine, Concord, N. H.

An arrangement for turning a four-bar crosshead wrist pin on an engine lathe is shown in the illustrations. The crosshead is first planed, centered and spotted on the top and bottom of the pin and placed in the lathe as shown in Fig. 1, counterweights being strapped on to make it run smoothly. The goose-neck tool

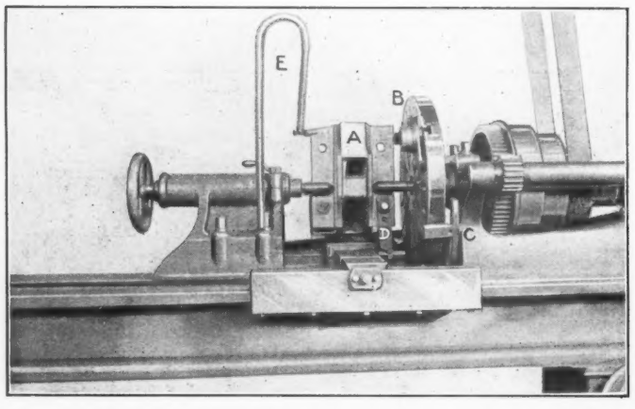


Fig. 1—Position of Crosshead at the Beginning of the Operation.

shown in Fig. 2 is used on the carriage of the lathe and is provided with right and left interchangeable heads, which are made on a swivel so that they will clear the work when the crosshead is returning to its original position. As shown in Fig. 1, the crosshead *A* is turned by the dog *B*, which is fastened to the faceplate and comes in contact with the arm *D* fastened to one end of the crosshead. The arm *C* is fastened to the bed of the

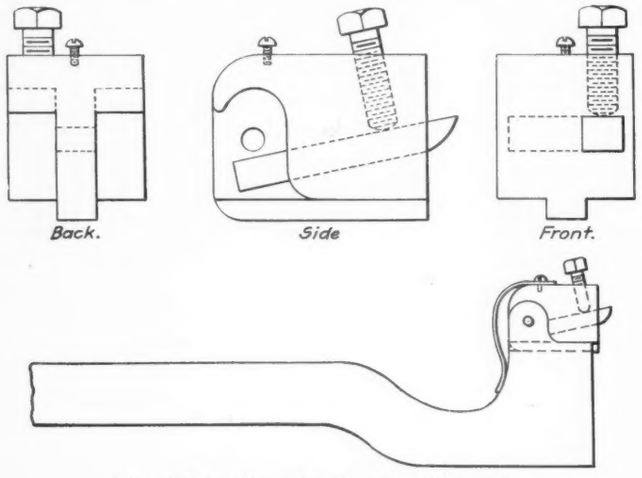


Fig. 2—Tool Used for Turning Wrist Pins.

lathe and trips the dog *B*, disengaging it from the arm *D* and allowing the coil spring *E* to pull the crosshead back to its starting position. Fig. 3 shows the crosshead just ready to be tripped. The construction of the driving-dog is shown in Fig. 4. When the arm *F*, located on the rear of the dog in a recess, comes in contact with *C* (Fig. 1), it turns the pin *G* which bears on the projecting arm *D* on the crosshead. One-half of the end of pin *G* is cut away. This allows it to disengage from *D* when it is turned by the arm *C*. A spring is fastened to the arm *F* so as to return it to its original posi-

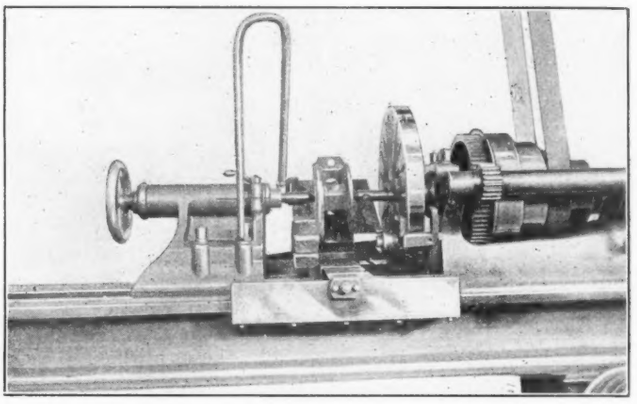


Fig. 3—Crosshead Just Ready to be Tripped.

tion after it has passed *C*. In this way the faceplate may rotate continuously and only turn the crosshead through one-half a revolution. One side of the crosshead pin is turned in this manner and then the crosshead is reversed in the machine

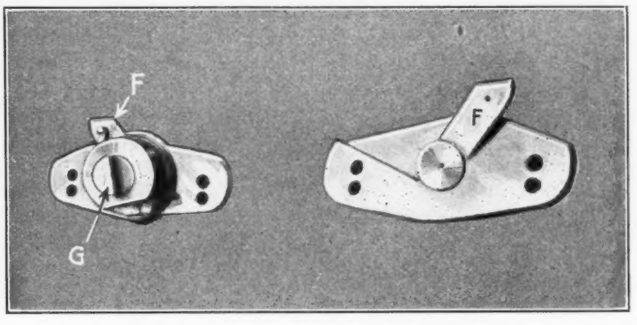


Fig. 4—Driving-Dog for Turning Crosshead Wrist Pins.

and the other half is turned. This device is simple and inexpensive, does good work and may be applied to any engine lathe with a faceplate.

RAIL CONNECTIONS BETWEEN VALENCIA AND MADRID, SPAIN.—The much talked of direct line from Valencia, Spain, to Madrid has not been included in the new law authorizing "complimentary" railways in Spain. The law only makes reference to the proposed line filling up the gap between the termini of existing lines at Cuenca and Utiel, and the Valencia people are not satisfied with this route, which is circuitous. On the other hand only 89 miles of line have to be built to connect these two termini, while of the proposed direct line via Motilla nothing is completed but the section from Valencia to Utiel. Valencia is the only large coast town which is not placed on one of the many direct lines which radiate from Madrid to the coast, although it is nearer than any other. As the crow flies the distance between the two cities is only some 186 miles, but the present route, via Encino, is 304 miles long, and the tri-weekly express takes 10½ hours to do the journey. By the Cuenca-Utiel route the distance would be reduced to 250 miles and considerably less again, via Motilla. Unfortunately, the latter route is through difficult country, and there is little hope of any local traffic of value, at least for a number of years to come, while the through passenger traffic is hardly enough to justify the present service of a daily mail train each way and an express every alternate week day.

SHOP IMPROVEMENTS AT BURNSIDE, ILL.

A Typical Illustration of What May be Done to Improve Power Conditions at Old Shops

Although the Burnside shops of the Illinois Central would hardly be considered as old shops, they have developed so rapidly during the past 10 or 15 years that in spite of boiler plant additions made in 1907, enough power was not available for the stationary engines situated in various parts of the plant. Soon after M. K. Barnum was appointed general superintendent of motive power an investigation was made by Willard Doud, shop engineer, and it was found that on account of the lack of facilities

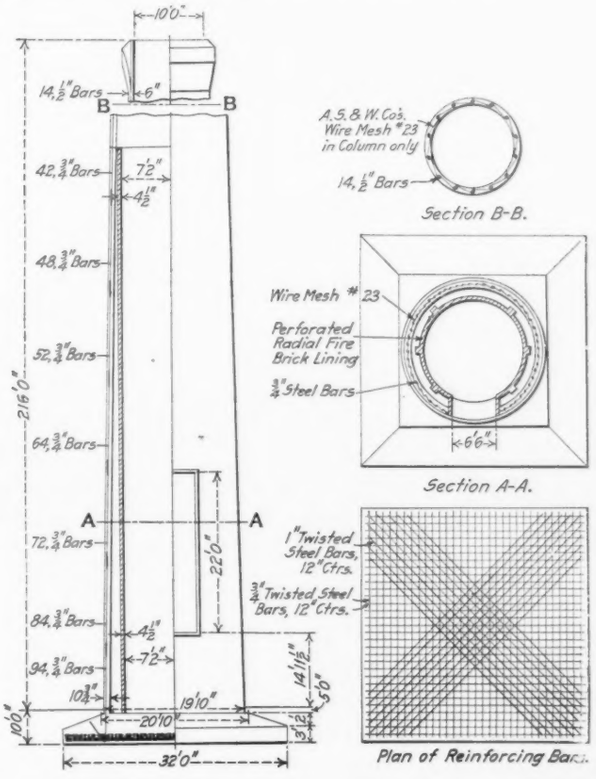


Fig. 1—Concrete Chimney for the Burnside Shops of the Illinois Central.

for handling coal and ashes, the steam was being generated at a comparatively high labor cost; that the boiler capacity could be increased by improving the chimney and ash pit arrangements; and that the cost of operating the engines distributed throughout the plant, and of transmitting the steam over the necessarily long distances, could be greatly reduced by the installation of motors throughout the plant, and generally electrifying the shops. It was also found that there was sufficient exhaust steam available in the mill engine room in addition to requirements for heating several buildings to operate low pressure turbines, which would provide the necessary amount of alternating current for the general electrification. A careful estimate of the cost of these changes showed that with an investment of about $150,000, a substantial saving could be made in the operation of the plant. These changes have been made, which clearly demonstrate what can be done in an old plant to bring the operating costs down to moderate proportions, and to increase the efficiency of the boiler plant.

BOILER PLANT.

The boilers were located in two buildings about 50 ft. apart, and consisted of three 300 h. p. Cahall water tube boilers in the smaller building, and eight 300 h. p. Erie City water tube boilers in the larger building. Nine of the boilers were equipped with Green chain grate stokers, and the products of combustion were taken care of by one brick stack 72 in. in diameter by 150 ft. high, one tile stack 86 in. in diameter by 153 ft. high, and two steel stacks 65 in. in diameter by 90 ft. and 77 ft. high respectively. All of this equipment was retained with the exception of the brick and steel stacks which were replaced by a 216 ft. reinforced concrete chimney 10 ft. inside diameter, designed by the M. W. Kellogg Company, New York, and shown in Figs. 1 and 2. It was found that the draft obtained with the old stacks had not been sufficient to burn the coal economically, and this chimney will more than handle the present number of boilers, and allow for increases in future. The 153 ft. tile stack handles the products of combustion for the 3 Cahall boilers in the second boiler house.

The handling of the coal from the cars to the boilers and the ashes from the ash pits was done entirely by hand, and

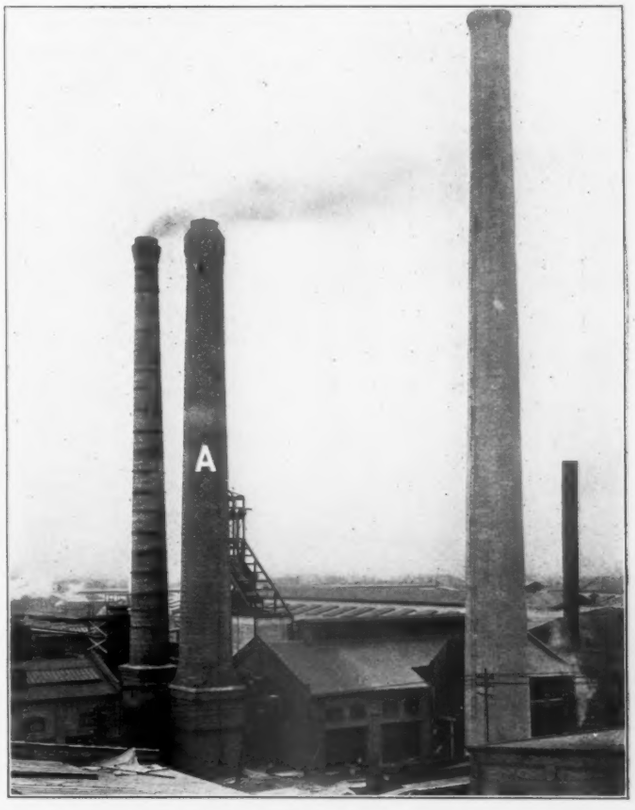


Fig. 2—Boiler House, Showing New Concrete Chimney.*

the labor cost for this work was excessive. A coal and ash handling arrangement was therefore installed, as shown in Figs. 5 and 6, which makes it possible to reduce this cost over 50 per cent. The coal is now dumped from the car directly into a depressed concrete hopper which feeds the coal automatically into two elevator buckets. These buckets are alternately raised to the top of the chute and automatically dumped into two storage bins above which a crusher is located for emergency use. From one of these bins it is distributed to a trolley conveyor, or hopper,

*The concrete chimney replaces the brick chimney *A*, the steel stack on the right and another steel stack, not shown, directly behind the new chimney. This photograph also shows the construction of the upper part of the coal chute. The receiving hopper and the coal crusher are plainly visible.

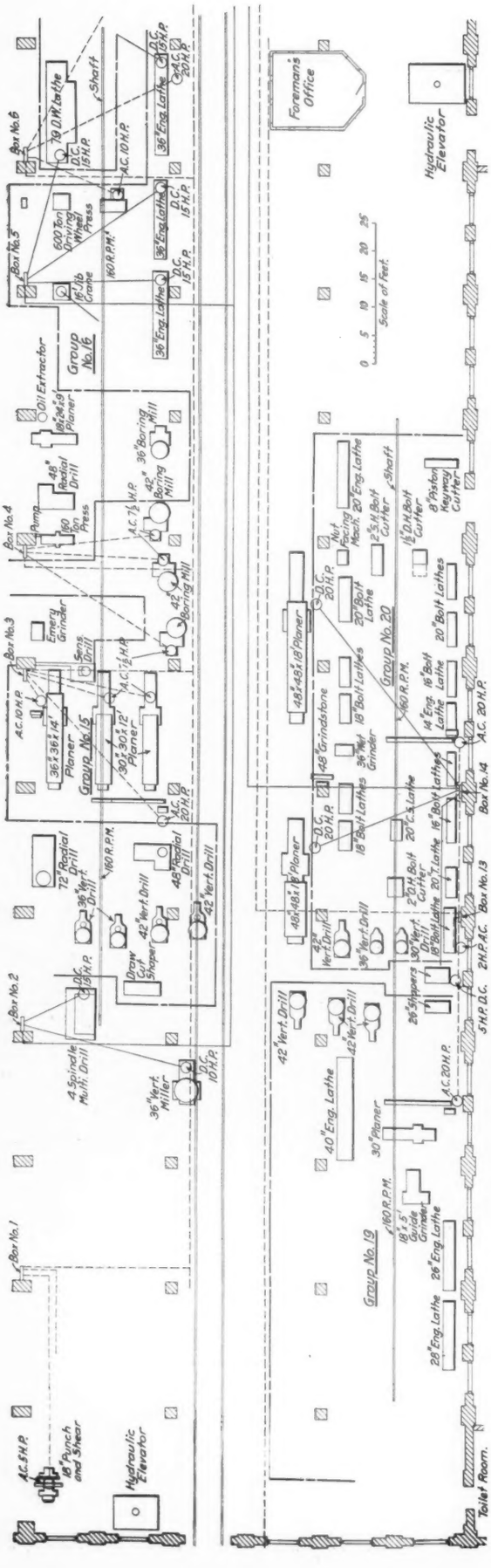


Fig. 3—South End of Machine Shop Showing Arrangement of Machine Tools, Motors and Wiring.

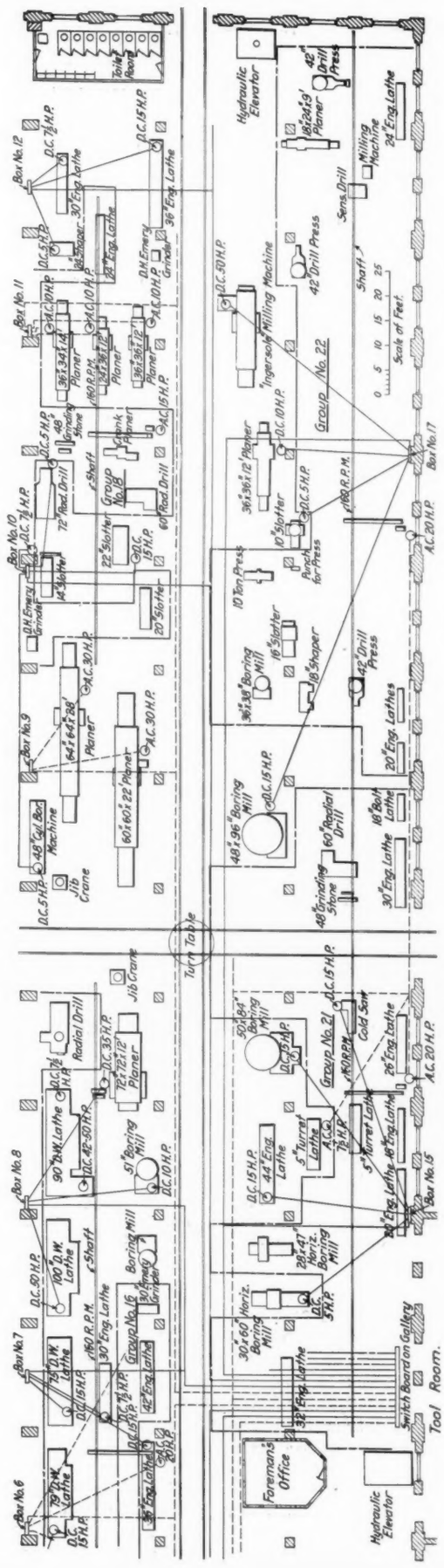


Fig. 4—North End of Machine Shop Showing Arrangement of Machine Tools, Motors and Wiring; Burnside Shops of the Illinois Central.

electrically operated, which feeds the stokers on the Erie City boilers in the main boiler house, and from the other to a belt conveyor which carries the coal over to the other boiler house

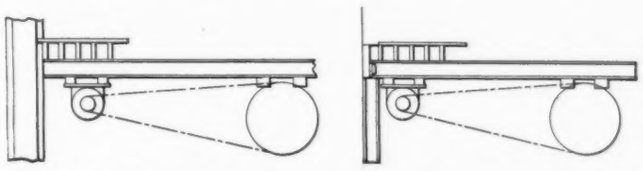


Fig. 4a—Arrangement of Motor Suspensions for the East and West Side Line Shafts.

for the three Cahall boilers. Two of these boilers are used for burning shavings and refuse from the planing mill.

It was also found that the ash pit arrangement permitted a leakage of air behind the grates which tended to cool the gases of combustion. To overcome this the stokers have been arranged to discharge into closed ash pits. The ashes are removed by a pneumatic ash conveyor designed by the Green Engineering Company, Chicago, which draws the ashes from the ash pit through a pipe to a separator and storage tank so located that the ashes may be dumped by gravity into a car for disposal. Two exhaust fans, each driven by a 30 h. p. motor running at 3,600 r. p. m., are installed for this purpose, one being held as an auxiliary. The ashes and air are separated in the receiver or hopper so that there is no eroding action possible in the exhaust fans. This arrangement has proved very efficient and has eliminated the necessity for more than 3 men in the ash handling gang.

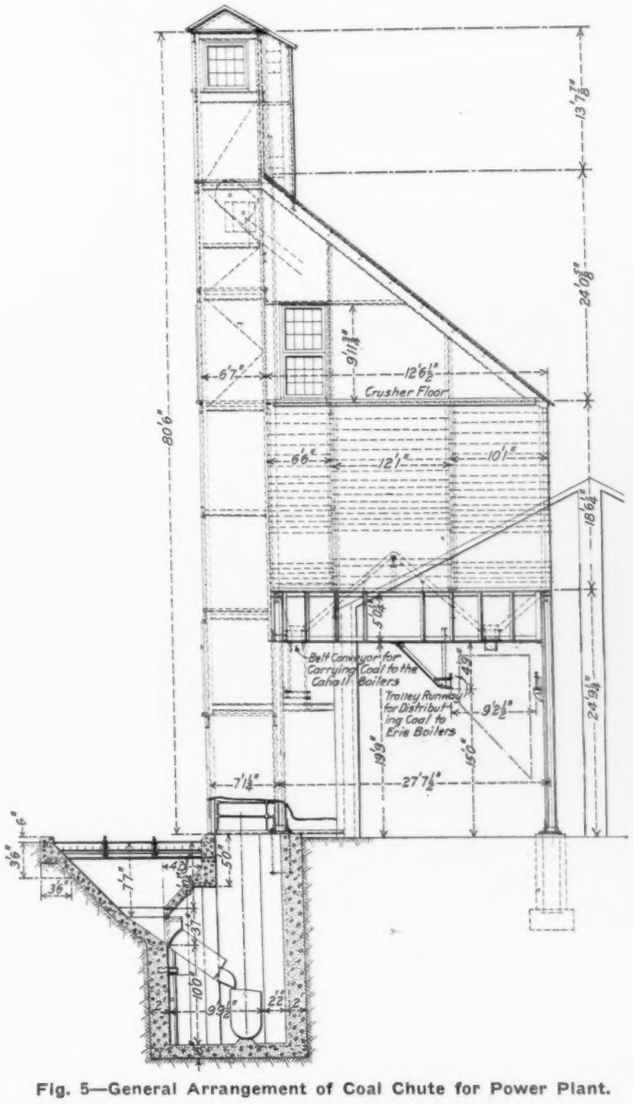

Crusher Floor
Belt Conveyor for Carrying Coal to the Cahall Boilers
Trolley Running for Distributing Coal to Erie Boilers

Fig. 5—General Arrangement of Coal Chute for Power Plant.

ENGINE PLANT.

The engine equipment consisted of various sizes of engines distributed throughout the plant at some distance from the boiler plant, which necessitated expensive labor costs and extensive steam lines with a corresponding loss in the transmission of steam. The engines in the mill engine room, which is near the boiler plant, were retained in service, but one 220 h. p. and 3 smaller engines in the machine and erecting shops, a 105 h. p. and 25 h. p. engine in the smith shop, and a 35 h. p. engine in the rolling mill, making a total of 7 engines, have been replaced by motors. An addition has been built to the mill engine room for two Allis-Chalmers 750 k. v. a., 3 phase, 60 cycle 440 volt direct connected mixed pressure turbo-generators arranged for normal operation on exhaust steam and shown in Fig. 8. While one is of sufficient capacity to supply the present demands for the additional electric power, two

Fig. 6—Coal Chute and Ash Separator for Power Plant

were installed as a matter of safeguard in case of breakdown, and to have ready means for supplying additional power when necessary to do so. The supply of steam for this equipment is taken from the engine equipment in the mill engine room, which consists of a 20 in. x 21 in. Buckeye single engine driving a 220 volt Westinghouse d. c. generator, a 28 in. x 48 in. Corliss driving the machinery in the planing mill, and two duplex air compressors, 22 in. x 30 in., and 20 in. x 26 in. respectively. A Westinghouse Le Blanc turbine driven condenser located on the engine room floor level is provided for each turbine, and the circulating water is cooled in a fan draft tower located adjacent to the engine room. Two 15 k. w., 125 volt Allis-Chalmers enciting generators are provided, one being driven by an a. c. motor and the other by a Terry turbine.

In making the change the only building originally using exhaust steam for heating where live steam is now used for the

same purpose was the machine and erecting shop where on account of the location of the building it was figured that the exhaust steam could not be used to any great advantage, and low pressure steam from the boilers is now used for the heating system. A 3,000 h. p. Platt Iron Works feed water heater was installed to heat the boiler feed water. Two 14 in. x 8 in.

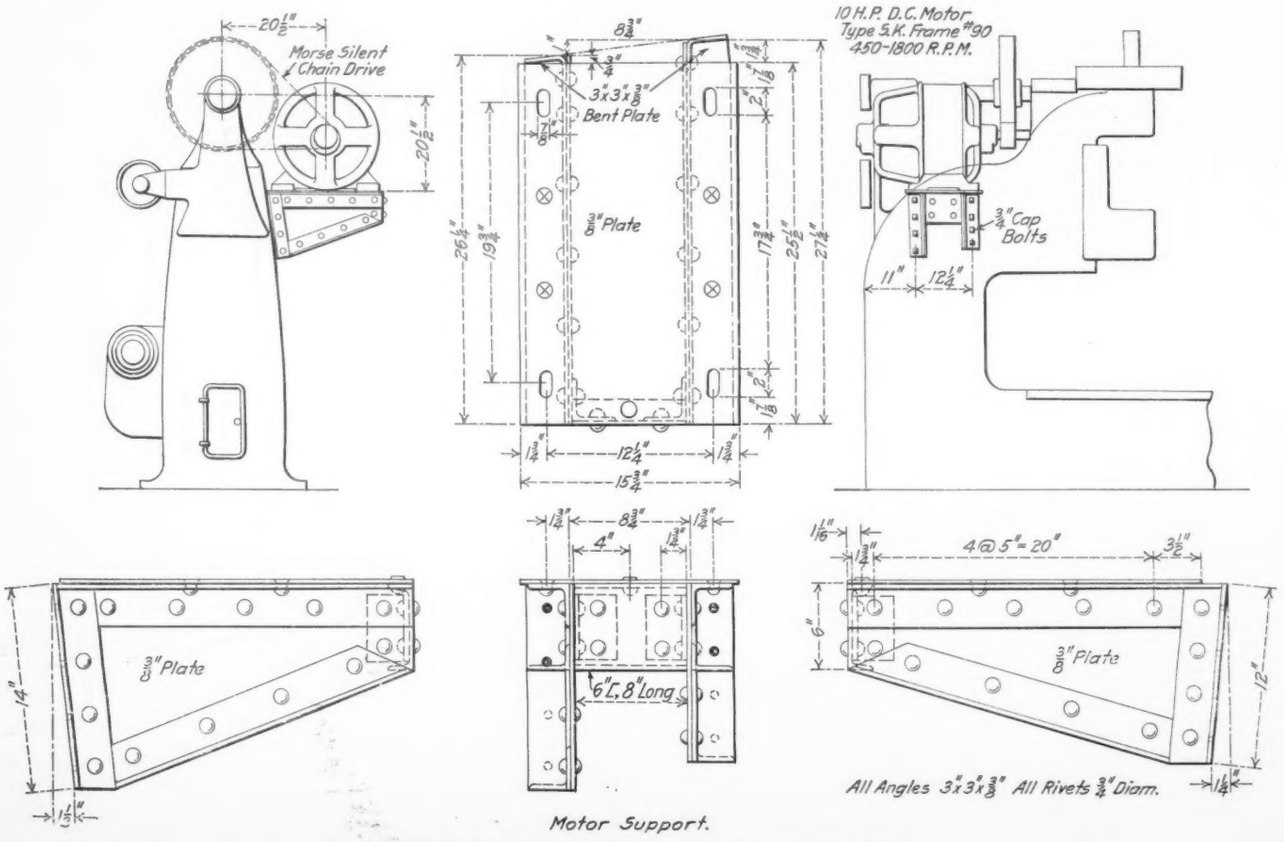


Fig. 7—Application of a Motor Drive to a Vertical Miller.

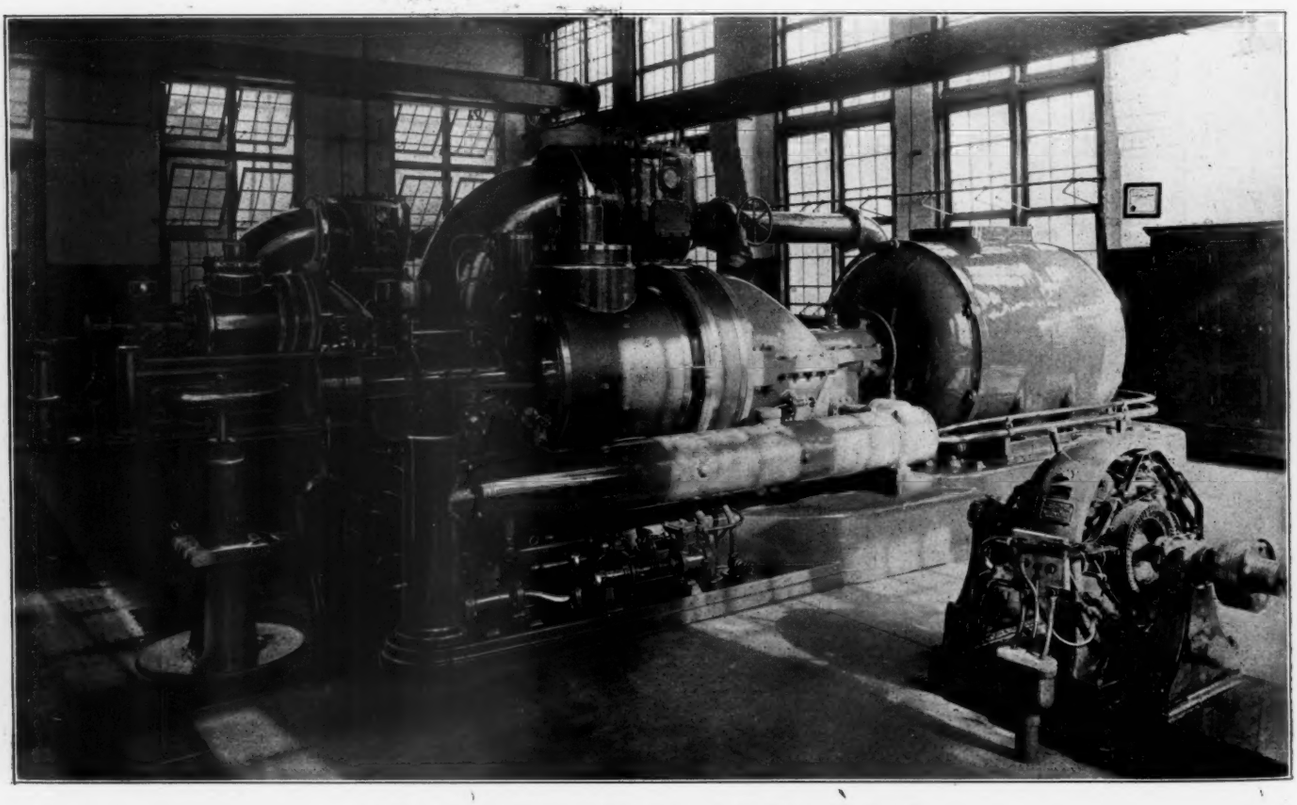


Fig. 8—Low Pressure Turbines and Le Blanc Condensor.

x 12 in. Blake pot valve pumps were also added for feeding the boilers.

MOTOR INSTALLATIONS.

With the addition of the alternating current generators it was found that a more logical and economical distribution of power could be effected, and in many instances direct current motors running at a constant speed were replaced by a. c. motors, the d. c. motors being used where variable speeds were required. In the machine and erecting shop the machines were divided into groups, as shown in Figs. 3, 4 and 4a, each group being driven by an a. c. motor. This greatly reduced the length of main shafts required, and also eliminated the attendant losses due to friction.

One noteworthy change was in the elimination of a rope drive

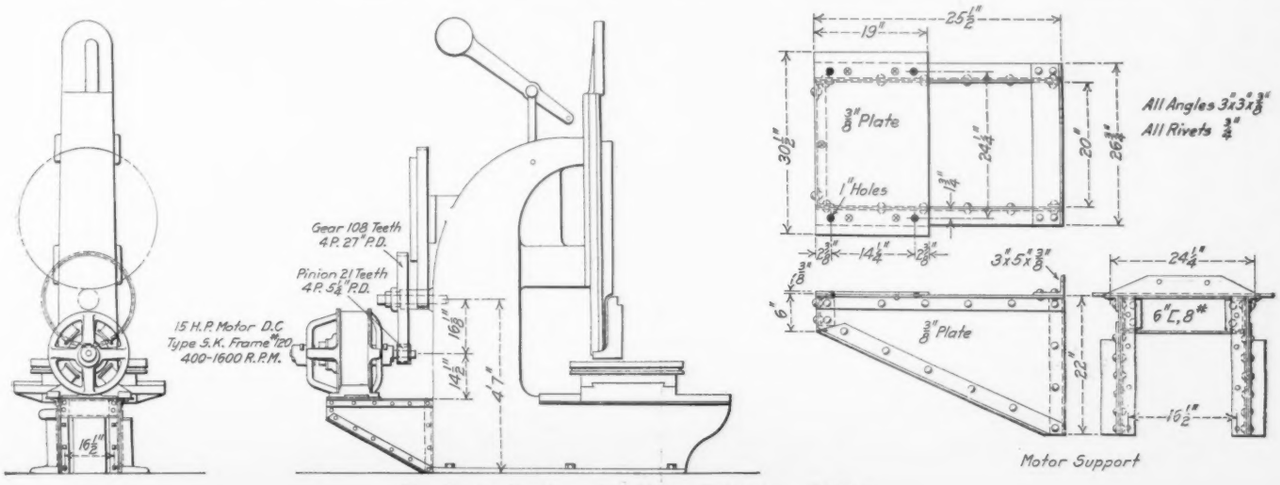


Fig. 9—Application of a Motor Drive to a Slotter.

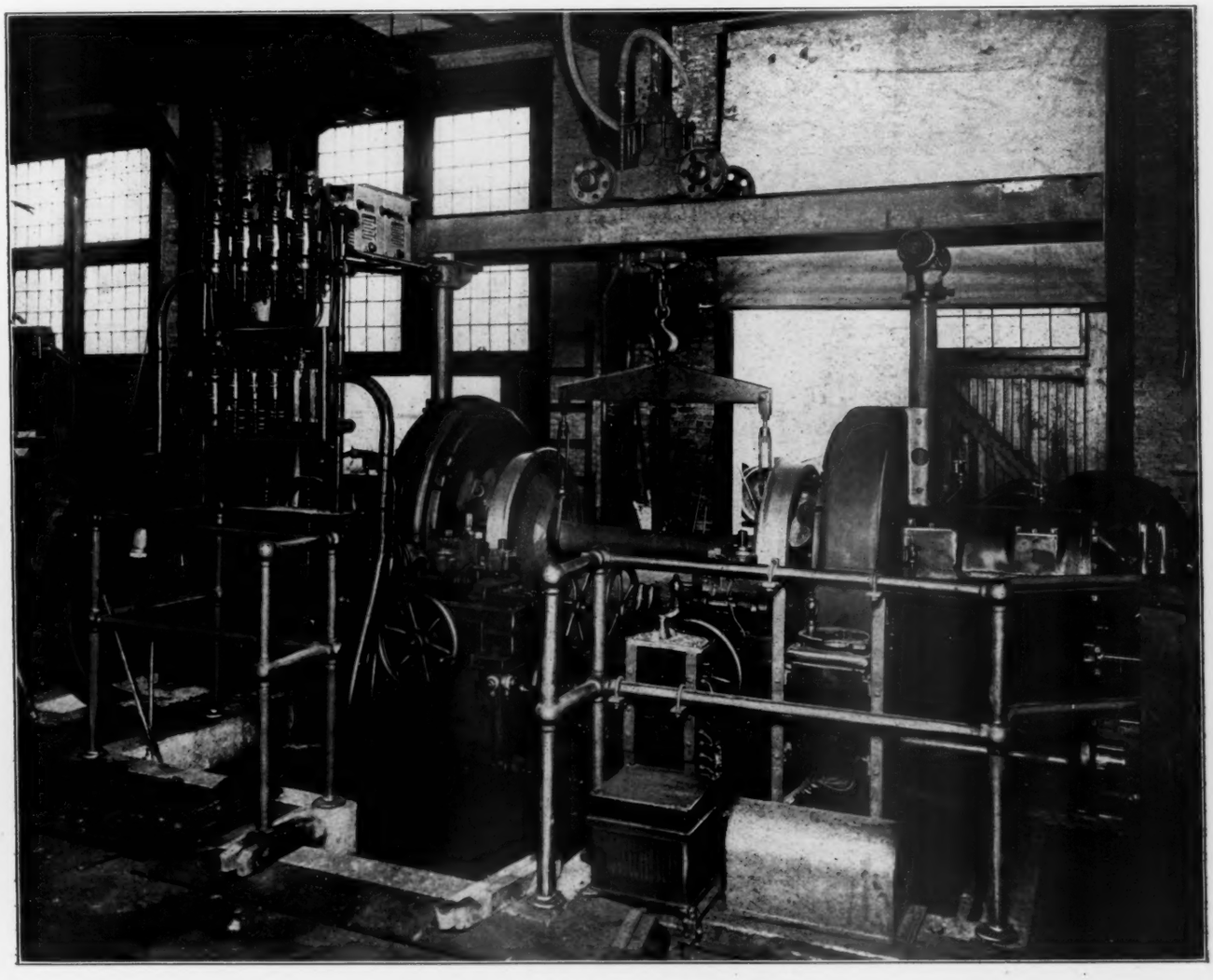


Fig. 10—42-Inch Motor Driven Car Wheel Lathe.

between the shaft of Group 21 and the shaft of Group 16, which will permit of locating a crane above a portion of the machine shop. The power required for each machine was carefully determined and a motor installed of sufficient power to drive each group. In some cases it was found that where a d. c. motor had been used an a. c. motor of much smaller capacity would answer the purpose on account of its rugged characteristics. Such an instance is shown in Fig. 11. The 15 h. p., a. c. motor in position on the wall is to replace the large 50 h. p., d. c. motor on the floor, and a chain drive is to replace the belt drive. It was also found that in some cases the motors could be directly applied to the machines more economically, and a few of the most interesting applications are shown in Figs. 7, 9 and 10. Fig. 10 shows a Sellers car wheel lathe driven by a 50 h. p., 220 volt d. c. motor with speed adjustment by field control from 500 to 1,000 r. p. m. Snap switches on the front and rear of the lathe enable the operator to start and stop the motor from either place. By means of a drum controller and suitable field resistance the desired speed is established. With one snap switch the motor is brought to this speed, while the other switch gives half speed for handling hard spots. Hence by combination of the controller and snap switches, the speed control is obtained without the intervention of gear changes.

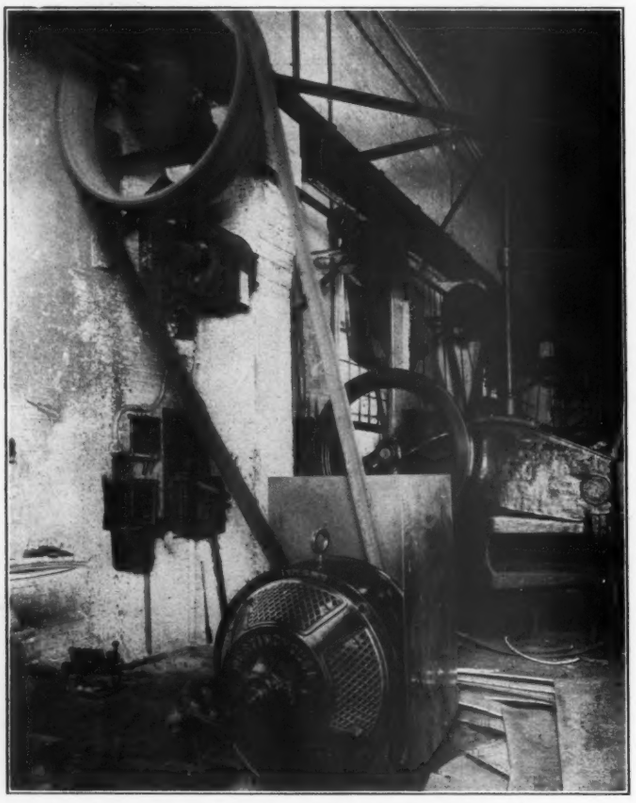


Fig. 11—A 50 h. p., 220-volt, d. c., Motor Replaced by a 15 h. p., 440-volt, a. c., Motor Placed on the Wall.

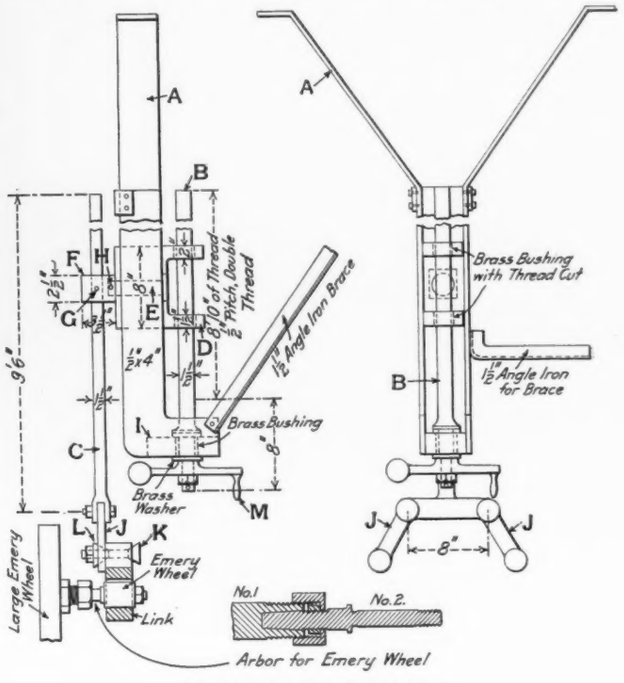
Throughout the whole installation the accessibility of motor control for the operator was carefully considered. All of the auto-starters are equipped with overload relays instead of fuses and no-voltage releases, which afford protection to the motors, tools and operators. In case of the group drive, provisions are made at three different places in each group for stopping the motor in case of accident. Where it was possible to do so the motors for the group drives were suspended from the walls or rafters so as to give all the floor space possible and place the motors out of the way of possible injury. Alternating motors will require very little attention. It was believed that by making these changes a distinct saving in the cost of operation of these shops would be made, production increased, a similar effect on the working floor space obtained, and that in general the shop operation would be much more reliable. Alternating current motors were also used to replace the engine in the blacksmith shop, and marked increases in output have been made by their installation.

The construction work, other than that applying to motors, was done by Westinghouse, Church, Kerr & Company, New York, and all of the new motors installed were male by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

A LINK GRINDING MACHINE

BY V. T. KROPIDLOWSKI.

In constructing the link grinder shown in the illustration, two pieces of ½ in. x 4 in. bar iron were used for the frame, but the writer believes that heavy 4 in. angles would make a more rigid construction. A crosshead *D* slides between the frame bars, and can be raised and lowered by a long rod *B*, which has a square thread. This rod fits into a block *I*, which is bolted between the bars of the frame. A handle *M* is provided to operate the screw. Through the crosshead a pin with a journal fit is provided, on the end of which a block *F* is fastened and kept from turning by a pin *H;* while through the block *F* is passed the rod *C*, which can be moved so as to suit the radius of any link, and is held in place by a set screw *G*. The lower end of the rod *C* has two jaws, from which are suspended two links *J*. These links have bolts *K*, which have taper heads, and which also are provided with a taper washer *L* and a nut, to suit any size holes in the different links. The arbor of the emery wheel that is used for grinding the links is attached to the arbor of a large emery wheel, which was already installed, this being done to obviate special shafting, pulleys, belts, etc. Referring to the illustration, No. 1 indicates the large arbor and No. 2 the small one. A medium grade of emery wheel is used and all the deep hollows are removed by this machine, the little polishing that is necessary afterwards being done by hand.



Machine for Grinding Links.

REPAIRING LOCOMOTIVE DRIVING BOXES

Brasses Cast in Place are Better Both as to Service and Cost of Repairs

BY M. D. FRANEY,
Master Mechanic, Lake Shore & Michigan Southern, Elkhart, Ind.

The design of the driving box and its associated parts, the machinery available in the shop, its relative location, as well as the organization of the shop have an important bearing on the proper method of repairing driving boxes. In the following study of the subject the functions of the driving box and its associated parts will be considered first and will be followed by a discussion of the proper method of making repairs.

The ideal driving box is one having a general construction of ample strength to permit maximum wear and the restoring of

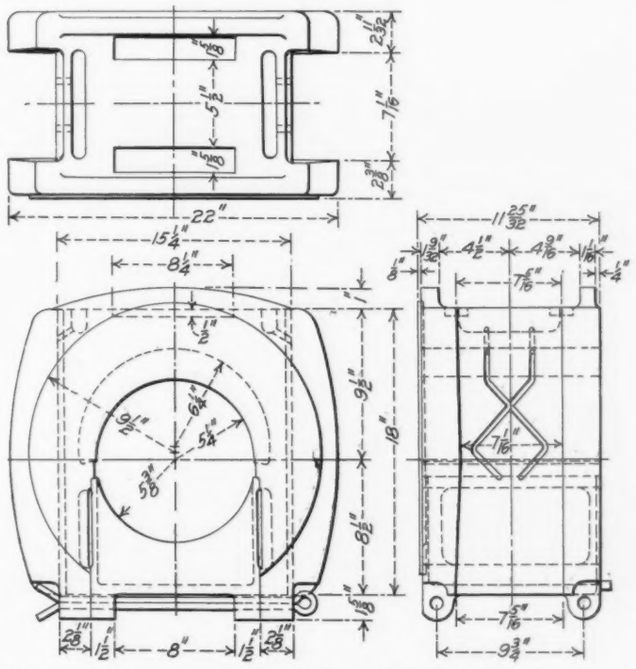


Fig. 1—Driving Box for the First and Third Axles of a Heavy Pacific Type Locomotive.

worn parts to their original dimensions. It should give the maximum service between general shoppings with a minimum amount of repairs. The following items affect the service and repairs; wear between the journal and the brass; the secure holding of the brass in the box; lateral wear between the driving box face and the driving wheel hub; securing and holding of the hub liners in the boxes and on the driving wheels; reducing to a minimum the wear between the shoe and wedge face and the driving box. The wedge bolts should have ample strength and a liberal bearing area between the bolt and the wedge. The flanges of the driving box for shoe and wedge fit should be tapered to prevent the raising of the brass from the journal, or the binding of the driving box and shoe and wedge during the rolling of the locomotive in service.

Experience proves that the wear on the main driving journal and brass is more rapid than on the front and back journals. This wear may be made to correspond to that of the other journals by increasing the length of the main driving journals by 18 or 20 per cent. This practice was tried on the Michigan Central at Jackson, Mich., in 1903 by D. R. MacBain, now superintendent of motive power of the Lake Shore & Michigan Southern. At that time Atlantic type locomotives on that road required the refitting of the main driving box brasses after 35,000 miles service. Increasing the length of the main bearing from 12 in. to 14 in. resulted in the same engines making 100,000 miles without refitting the boxes.

Fig. 1 shows the No. 1 and No. 3 box, and Fig. 2 the main axle driving box of a 22 in. x 28 in. Pacific type locomotive equipped with a superheater and carrying 200 lbs. steam pressure. The details of the method of holding and fastening the brass are shown in Fig. 3. It will be observed that this box is made to receive the brass in a molten state. Five dovetails are slotted in the crown of the box, two holes 1 in. in diameter are drilled in the center dovetail and the hub face of the box is dovetailed to receive and hold the brass hub liner which is poured and cast on the box at the same time as the crown brass. The hub liner is a part of the brass, and with the two 1 in. projections in the two 1 in. holes, *A* and *B*, in the center dovetail it prevents the brass from working out, should it become loose in the box. The five projections on the crown brass are held closely to the sides of the dovetails in the box by shrinkage.

One great advantage of the poured brass over the pressed one is that a higher percentage of lead can be used without segregation. The sudden cooling in the steel box gives a very close grained uniform bearing metal. The poured brass with its high percentage of lead makes an ideal bearing and having the hub

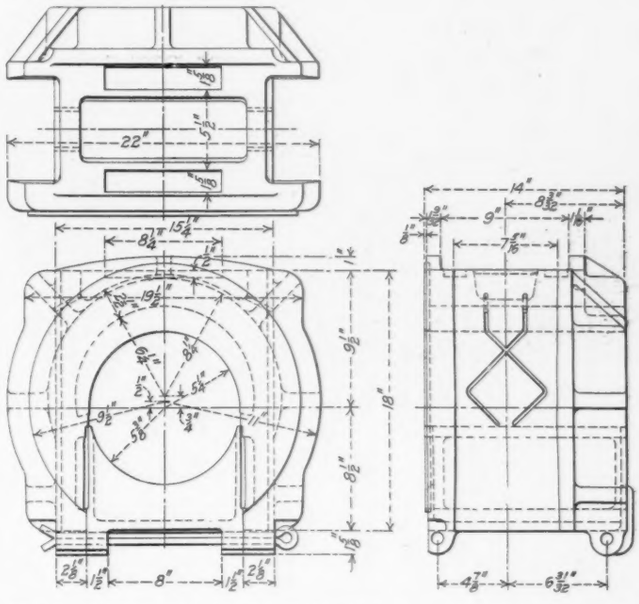


Fig. 2—Driving Box on the Main Axle of a Heavy Pacific Type Locomotive.

liner cast solid with it, in addition to the dovetail, makes an excellent method of fastening the hub liner as well as a cheap method of renewal to standard dimensions. There is a saving of labor in turning, shaping, pressing in, drilling and pinning the brass, and the pouring of the brass in the steel box costs less than pouring in a sand mold.

In applying new driving wheels there is no good reason why metal should be removed from the wheel hubs and similar metal patched on with bolts. The wheel hub should be left solid to

take the lateral thrust of the box. The writer has seen hubs without liners, except on the box, in service eight and ten years, which were in good condition.

Cast iron shoes and wedges and cast steel driving boxes do not make a satisfactory wearing combination and in the boxes illustrated two dovetails and two 1 in. holes are provided to hold the bronze liners, which are cast in place. This not only provides good bearing material, but also permits liberal fillets

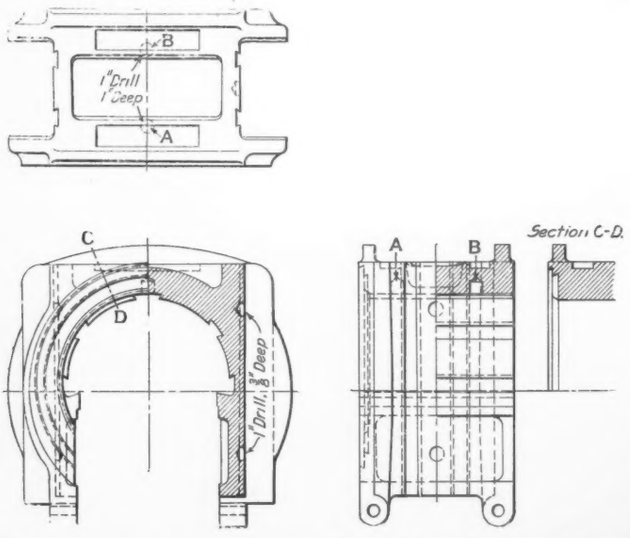


Fig. 3—Arrangement of Recesses for Holding the Crown Brass and Liners.

where the flanges join the steel driving box casting, which adds to the strength of the construction, and yet, when the liners are cast in place, allows the use of sharp corners on the shoes and wedges which gives a bearing on the full area of the shoe and wedge face. On the shoes used with these boxes there is an increased bearing area of 13½ sq. in., as compared with a similar wedge having a fillet of ⅜-in. radius. This reduces the wear between the shoe and wedge and the driving box face and also

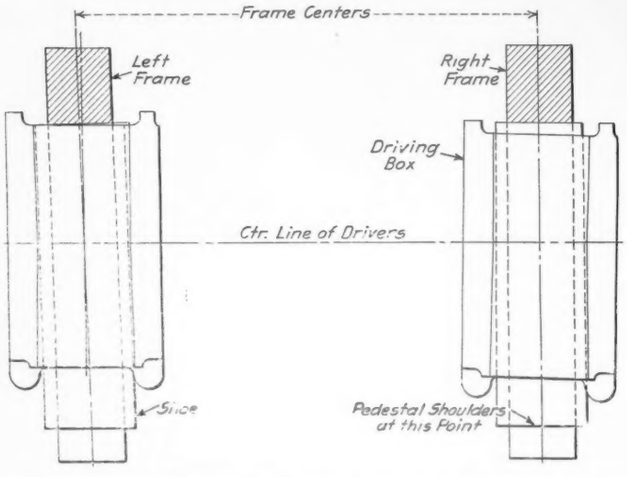


Fig. 4—Relation of the Driving Boxes and the Frames When the Driving Wheel Strikes a High Spot on the Track.

reduces the pounding. The brass face against cast iron permits a closer adjustment than with cast iron and steel.

Fig. 4 shows why the driving box flanges should be tapered to prevent the driving boxes tipping on the journals with the swinging and rolling of the locomotive. This clearance also prevents the binding of the driving boxes and the shoes and wedges with the resulting breakage of the flange on the box, the shoe and wedge flange, the wedge bolt, or all three.

SHOP PRACTICE.

The shop practice for finishing new driving boxes of this type in a shop repairing 650 engines per year has been well standardized and the results are very satisfactory. In the following description, the time given in each case is the average time required and includes dead time. It is based on piece work pieces and covers an extended period of time. All driving wheel and box repairs from the time the wheels are removed from the locomotive until they are again ready to place under it, are handled by the driving wheel and box department of the machine shop.

The new box as it is received from the foundry is clamped by bolts in the ordinary method on a 42-in. Bullard vertical turret lathe; both faces of the driving box are finished to the proper dimensions, and the hub face is dovetailed to receive the hub liner. This operation requires 90 minutes from floor to floor and costs 65 cents per box. The box is trucked from the boring mill to the slotter at a cost of 1 cent. The circle and dovetails are slotted to receive the poured crown brass. This requires two hours and costs 96 cents per box.

Experience in pouring driving box brasses has shown that the shrinking of the metal tends to draw the box in on the lower

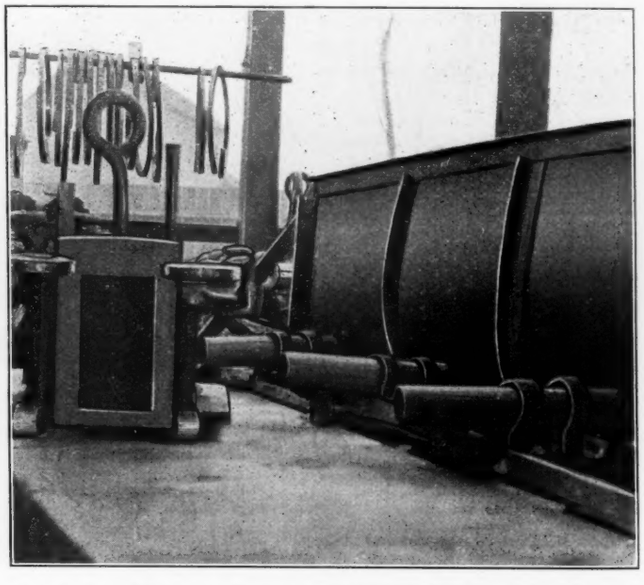


Fig. 5—Face Plate and Burners for Heating the Box Preparatory to Pouring the Brass.

end and for this reason the new box is not milled for the shoe and wedge fit, or slotted for the cellars until after the brass is poured.

It requires eight minutes to take the box to the brass foundry and costs a little over 3 cents a box. The brass is melted in a Rockwell furnace and a special face plate with four special burners is provided for the pouring. This is shown in Fig. 5. Fuel oil is used in the burners and the boxes are heated to about 900 degrees before the brass is poured. A cast iron core with a pin projecting from the lower end is set in a receptacle just opposite each burner. This core has projections which core out the grease grooves and recesses to receive the sand cores for babbitt grooves; the brasses as poured are small enough in diameter to finish nicely to minimum size of journal for each class of engines. The hub liner in its molten state is retained in position on the box by wrought iron guards, about 1 in. high, providing ample stock for facing it to the required thickness and insuring the removal of all dross and waste material. Slots are provided in the edges of the iron cores and two wedges are used in each slot, one of the wedges is inverted and by driving the other it is easy to center the box on the core. These wedges form the mold for the lower edges of the brass.

In beginning the operation, the box is set on the face plate resting on its back face at the proper distance from the cast iron core. When properly located in respect to the core it is secured and the cast iron core is removed. The burner is lighted and the box is heated to its proper temperature. The guard for the hub liner is then placed on the box and the core is returned to place and the wedges driven down and all open places are closed with asbestos cement. The molten brass is then poured in the ladle and allowed to cool to a dull red heat before pouring in the box. Fig. 6 shows the operation of pouring.

Setting up the box on the face plate, heating, applying the

Fig. 6—Pouring Driving Box Crown Brass and Hub Liner.

guards and liners and pouring the shell and hub liners requires 30 minutes and costs 16 cents a box for labor.

The box is now returned to the milling machine and is securely clamped to a heavy angle iron. One end of the box is offset so that in milling the first shoe and wedge face the milling cutters also cut half the taper on the flanges. After the milling cutter has passed through, the boxes are reset by adjusting the wedge on the opposite edge of the box which completes the operation of milling the shoe and wedge face and tapering both ends of the flanges on one side of the box. The box is then turned over and the same operation is performed on the other side. This requires 2½ hours and a labor cost per box of one dollar, with 25 cents added for setting up on the machine, which usually applies for several boxes. This operation could be somewhat reduced if a heavier milling machine was used.

The box is trucked to the planer, which is in the same department, and the two dovetails are planed on each shoe and wedge face to receive the brass liners. This takes on an average of 45 minutes per box and costs 37 cents. It is then trucked to the brass foundry for pouring the shoe and wedge liner.

For pouring these liners, cast iron formers which fill the space between the flanges of the driving box and for the full length of the shoe and wedge face are provided. Four taper pins on the face of the liner hold it a proper distance from the box. Two formers are used for each box and are held in place by clamps. The labor for applying formers and pouring the side liners costs 6 cents a box.

The box is taken to the planer at a cost of a little over 3 cents and the brass gibs are planed to the proper thickness to give the required width on the shoe and wedge face. This is handled on an ordinary 36-in. planer and the time required for setting up, finishing both sides and removing to the floor is 38 minutes and costs 30 cents for labor. The box is next delivered to the slotter and is slotted for the cellars which consumes 50 minutes and costs 38 cents.

Cleaning the sand out of the oil pocket and out of the babbitt slots takes 14 minutes per box, costing 7 cents. It is then trucked to the babbitt fire, babbitted and returned, requiring 12 minutes at a labor cost of a little over 8 cents.

The box is bored for the journal fit on an old Putnam wheel boring machine, which has been fitted up for this work. It is shown in Fig. 7 with a finished box in position. A heavy extension is provided on the end of the boring bar which extends into a sleeve in the table, so designed that the chips cannot cut the bar. An adjustable tool holder is provided in the bar and a double end tool is used. One end of the tool is for roughing and the other for finishing. A horizontal head is used for facing the hub liners. A ⅛-in. feed and a ¼-in. cut is used for rough boring and a 3/32-in. feed and a ¼-in. cut for facing, both operations being performed at the same time. A canvas curtain encloses the machine while boring and facing. The box is clamped with four heavy clamps and key-bolts.

The box is bored central with the shoe and wedge faces by using a special adjustable gage, Fig. 8, measuring from the shoe

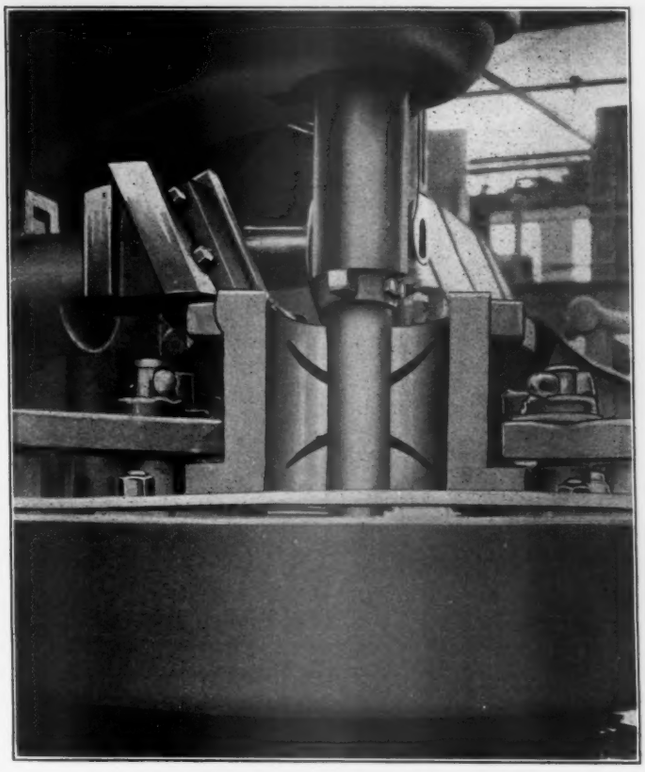


Fig. 7—Boring the Brass and Facing the Hub Liner.

and wedge face to the extension on the boring bar. This is also used for measuring from the steel box to the bar for the proper thickness of the crown brass. The operator is required to caliper the journal and is responsible for the proper fitting of the brass on the journal. Front, back and intermediate brasses are bored 1/32 in. larger than the journal and the main brass is bored to fit the journal. This is for engines equipped with grease lubricators. Setting up the box in the boring mill, calipering the journal, boring the brass and facing the hub liners to proper thickness takes but 25 minutes from floor to floor. The total cost of these operations is 25 cents.

The box is next delivered to the drill press in the same department and is drilled for the cellar bolts and oil holes. This takes one hour at a cost of 28 cents.

Planing the cellars to fit the box takes 25 minutes, fitting the removable grease doors to cellars five minutes, and drilling the holes in the cellars and grease doors 15 minutes. The cost for the three operations is 28 cents.

The box is delivered to the fitter who fits it to the journal, cleans the sand out of the grease groove with an air hammer and special chisel, removes the burrs and squares up the spring saddle. This takes one hour.

Placing the box on the journal, packing the grease in the cellar, fitting up a new grease plate and spring plate, fitting the cellar in the box and putting in the cellar bolts complete requires another hour.

This completes the operations on a new box ready for applying

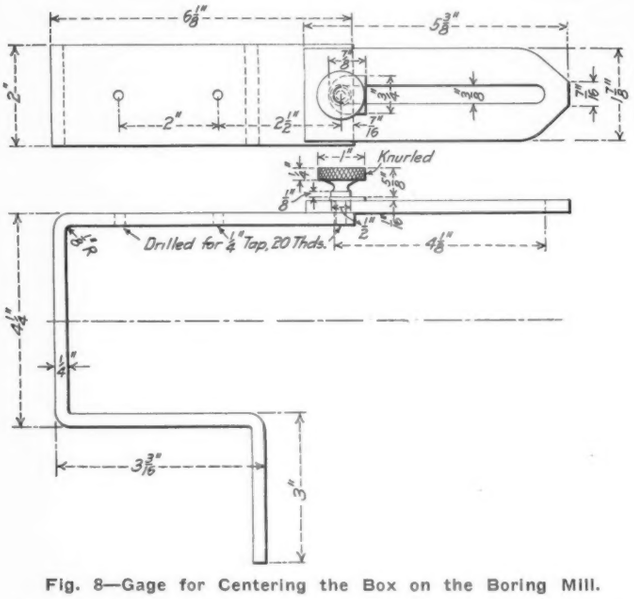


Fig. 8—Gage for Centering the Box on the Boring Mill.

the wheels under the engine. The total time as shown by the recapitulation is 14 hours and 41 minutes.

Summary—New Driving Boxes.

	Time. Minutes.	Cost for Labor. Cents.
Clamping on the boring mill, finishing both faces, dovetailing for the hub liner	90	65
Trucking to the slotter	..	1
Slotting the circle and dovetail for the brass	120	96
Trucking to the brass foundry	8	3.2
Setting on the face plate, applying the formers, heating the box, pouring the brass and hub liner	30	16
Trucking to the milling machine	8	3.2
Setting up on the milling machine, milling the shoe and wedge face, including the tapering of flanges	150	100
For setting up the milling machine for the above operation	35	25
Setting on the planer, planing two dovetails in each face for shoe and wedge liner	45	37
Trucking to the brass foundry for pouring shoe and wedge liner	8	3.2
Applying the formers, heating the box, pouring the side liners	15	6
Trucking from the brass foundry to the planer	8	3.2
Planing brass gibs on shoe and wedge face	38	30
Slotting for the cellar	50	38
Cleaning the sand out of the oil pockets and babbitt slot	14	7
Trucking to the babbitt fire, babbitting and returning to the boring mill	12	8.3
Setting in the boring mill, calipering size of the journal, boring the brass, and facing the hub liner to proper thickness	25	25
Drilling the cellar bolt holes and oil holes for the shoe and wedge face	60	28
Planing the cellar to fit	25	20
Fitting removable grease doors to the cellars	5	2
Drilling the holes in the cellars and grease doors	15	6
Removing all burrs and sharp edges from the brass and hub liners, cleaning the sand out of the grease grooves in the brass, squaring up the spring saddle, and chipping the oil grooves in the shoe and wedge face, leaving the box ready to go on the journal	60	47
Filling the grease groove, placing on the journal, applying the spring grease plates and followers complete in the grease lubricator, filling the grease lubricator, placing the cellar in the box, and putting in the cellar bolts	60	35
Total	14 hrs. 41 min.	$6.05

In handling an old box for repairs, the box is first removed from the axle and after the grease is taken from the cellars and placed in receptacles provided for the purpose, the box and cellar are placed in a basket for the cleaning vat. This work, including taking the box and cellar to the lye vat and cleaning and then returning them to the driving box department, requires twenty-eight minutes and costs about 13 cents.

Inspecting the driving box and pressing out the shell consumes sixteen minutes at a cost of about 6 cents. Where it is necessary to chip out the hub liners the time will be thirty minutes.

In removing the brass side liners for the shoe and wedge it is more satisfactory to plane them out and the cost of doing this by splitting them in two in the center with square nosed tool and removing the parts is also about 13 cents.

Trucking the box to the brass foundry for pouring a new brass and liners takes 8 minutes and costs a little over 3 cents. Setting up the box on the face plate, heating it, pouring the brass including the hub liner, applying formers for the side liners and pouring the side liners takes 45 minutes at a cost of 22 cents.

With repaired boxes all of the brass foundry work, including pouring of the hub and side liners, is performed at one time.

The box is then trucked to the planer and the side liners are planed to the original dimensions. This takes 38 minutes and costs 30 cents a box. Where the old shoe and wedge liners can be used and it is only necessary to plane them each box is planed to width separately. This is good practice as it preserves a maximum thickness of liners on the box. On the erecting floor the width of each box is laid out on its own pedestal from its respective center.

After the sand is chipped out of the oil pockets and babbitt slots in the shell the box is trucked to the babbitt fire, babbitted and returned to the boring mill. It is bored in the same way as a new box.

The box then goes to the fitter, the sand is cleaned out of grease grooves and the brass is fitted to the journal and the spring saddle bearings are squared up. It is now ready to be applied to the journal, after which the foreman inspects it for fit; the grease with lubricator is applied and the cellar is bolted in place and the box is ready for service.

Summary—Old Driving Boxes.

	Time. Minutes.	Cost for Labor. Cents.
Removing the box from the axle	8	3.2
Removing the grease from the cellars and placing the box in the basket for cleaning	5	2
Taking the box and cellar to the lye vat and cleaning	9	4
Trucking to the driving box department	6	2
Inspecting the box and pressing out the brass	16	6.3
Chipping out the hub liners	30	13
Planing the side liners and removing	18	13
Trucking to the brass foundry for pouring the liners and brass	8	3.2
Setting the box on the face plate, heating, pouring brass, hub liner and side liners	45	22
Trucking to the planer	8	3.2
Planing the side liners	38	30
Chipping sand out of the oil pockets and babbitt slot in the brass	14	7
Trucking to the babbitt fire, babbitting the brass and returning to the boring mill	12	7
Setting on the boring mill, calipering journal, boring the brass, facing the hub liners	25	25
Removing all burrs from the brass and hub liners, cleaning the sand out of the grease groove, chipping the grooves in shoe and wedge face. Box ready to go on the journal	60	47
Filling the grease grooves, applying on the journal, fitting up the lubricator complete, applying the cellar, putting in the cellar bolts. Box ready for service	25	13
Total	5 hrs. 27 min.	$2.00

As stated in the beginning the detailed handling of driving box repairs will necessarily be varied to suit shop conditons, type of machinery, its relative location and the design of box used. It should be understood, however, that a few extra cents saved in the cost of repairing driving boxes may result in dollars spent in the roundhouse before the engine comes back for general repairs. The principal item to be considered first and always is the design of the driving box and the method of repairing, which will enable the engine to go from one general shopping to another with the last amount of repairs.

CAR DEPARTMENT

CAR DEPARTMENT NOTES

BY KEYSER.

Is there a railroad anywhere on which a car foreman can have the repair tracks switched at the time they need it? My experience has been something like this: The car foreman orders one of the repairmen to "Go up and tell the yardmaster we want a switch here in half an hour." The repairman returns in 45 minutes and says that after tramping all over the yard he finally found the yardmaster, who informed him that "he couldn't switch the rip tracks before dinner." There being, by this time, from two to twenty repairmen idle, the foreman proceeds to find what he can to keep them busy temporarily and sets out himself in search of the yardmaster. When he succeeds in running him down they spend another ten minutes in loud-voiced discussion that accomplishes nothing; the foreman returns to the repair track and cools his wrath by telling what should, in his opinion, be done to the yardmaster and the rest of the transportation officials, while the yard crew go about their regular work and switch the repair tracks when they get around to them.

I do not pretend to offer a solution of this problem. I have seen a number of trials made to solve it—designating certain times for the switching, etc.—but I have never yet known one of them to work out satisfactorily. Conditions vary so much at the terminals that a different treatment may be needed for each one, or at least each class of terminal; but I believe that the way to go about solving it is to have the matter thoroughly threshed out in a conference between the superintendent, the master mechanic or division master car builder, the yardmaster and the car foreman. Certainly something should be done to avoid the delays and consequent waste of keeping car repairmen waiting for switch engines.

* * * * * *

When a man is made car inspector he sometimes gets the idea that all he has to do is to go around tapping wheels with a hammer and looking wise. There are plenty of railroads on which cars are set out and delayed on the repair tracks for trivial repairs, while a car inspector sits and gossips in the yard office. This may be largely overcome by erecting a small shanty for the inspector, within a reasonable distance of his work, and placing in it a small supply of brasses, nails, bolts, etc. The inspector can then, in many cases, very easily make such light repairs as are necessary without marking out the car and necessitating its removal to the repair track. There are great possibilities in this for the saving of money for the company and in preventing delays.

* * * * * *

I talked to the foreman of a coach cleaning yard recently when a number of men were at work nearby washing down cars. I noticed two other workmen bring out a number of cushions and aisle carpets and one started blowing the dust out of the carpets with a compressed air cleaner, while the other commenced pounding the cushions. I expected to hear the foreman at once order these two elsewhere, but not a word was said. The dust blew against the wet cars and, of course, stuck there, and the train went out with several cars looking much worse than when they arrived, for the reason that they were uniformly dirty coming in and were spotted irregularly going out. Possibly the moral is "use vacuum cleaners," but until the appropriation goes through, a little thought on the part of the foreman would help materially to brighten the exterior of the passenger equipment.

When work trains are being operated, the aprons which carry the unloading plow from car to car are frequently a bane to the carman's existence, one of the prolific causes of trouble being the leaving down of the end apron by trainmen and conveniently forgetting it. The sequel is the backing in of another locomotive or train and the consequent crumbling up of the apron. It is useless to report these happenings. The superintendent may post bulletins and admonish from morning to night and trainmen will still "forget" the aprons. The easiest way is to assign a man several times a day to go over all the trains which may be awaiting load, or standing idle for any other reason, and have the end apron turned back; then it will not matter whether or not the trainmen forget.

* * * * * *

It is just as easy to load car wheels properly as improperly, but it is surprising how many carmen, and even foremen, will, in unloading wheels, place them so that the flanges of one pair rest against the journals of the next. The result to the journals may be readily imagined.

* * * * * *

The "safety first" campaign has resulted in great improvements as regards material left lying along the tracks in such a manner as to possibly cause death or injury to trainmen; but how common it is to see drawbars, draft sills, etc., left lying right where they fell when removed from a car on the repair tracks, the men in the meantime walking, or rather stumbling over them while about their work. In most cases a few steps and a few seconds more would place the old material out of the way, so that the men could work and move about with comfort and convenience.

While talking of safety, did it ever occur to you how easily a protruding nail or broken board on a roof or the floor of a flat car, could throw a trainman from the car? These are among the little things that, if let go, may cause serious injury or loss of life. I know of repair yards where one or more men are kept busy all the time looking for and remedying small defects of this nature. Aside from the safety feature, a loose nail may very soon mean a leaky roof.

* * * * * *

I was much surprised recently to see a number of men engaged in shoveling back and boarding up the grain in a box car in order to get at the draft timber bolts, which were broken. There is a device, which I was under the impression was in general use, by which this work can be much simplified. It consists of a bottomless box or cylinder, about four feet in diameter or square, as the case may be, made of ⅛ in. or 3/16 in. iron; it is sunk to the floor of the car and the grain shoveled out. It may be made in a boiler shop in a few hours.

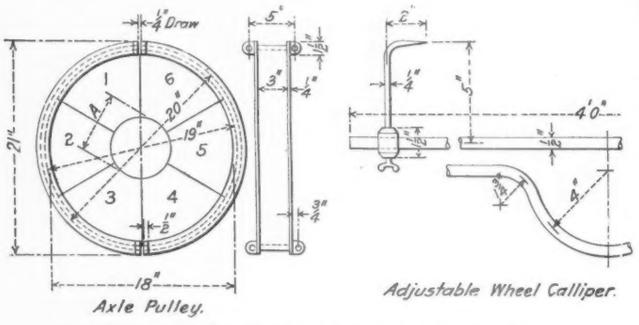
* * * * * *

Many car foremen, unless the general storekeeper is watchful and checks their requisitions closely, follow the practice of ordering more material each month than they need, regardless of what is due on previous requisitions. They follow the old rule of ordering double what is needed because the stores department will reduce the amount by half, anyway. I believe that it requires no more clerical work and gives more satisfactory results to keep close track of what material is on order, and instead of ordering another supply each month, keep after the storekeeper until the old requisitions are filled. In many instances, if a foreman were to suddenly have all his outstanding requisitions filled he would not be able either to store or use the material.

REMOVING FLAT SPOTS FROM CAR WHEELS

BY CHARLES A. CURTIS, Jr.

Flat wheels are hard on the road bed and rolling stock, and are frequently the cause of much ill-natured comment on the management, particularly in the case of passenger equipment. The traveling public is looking for the best service, and smooth running wheels play a big part in it. The device described in this article will remove flat spots quickly and cheaply, without the necessity of removing the wheels from the car.

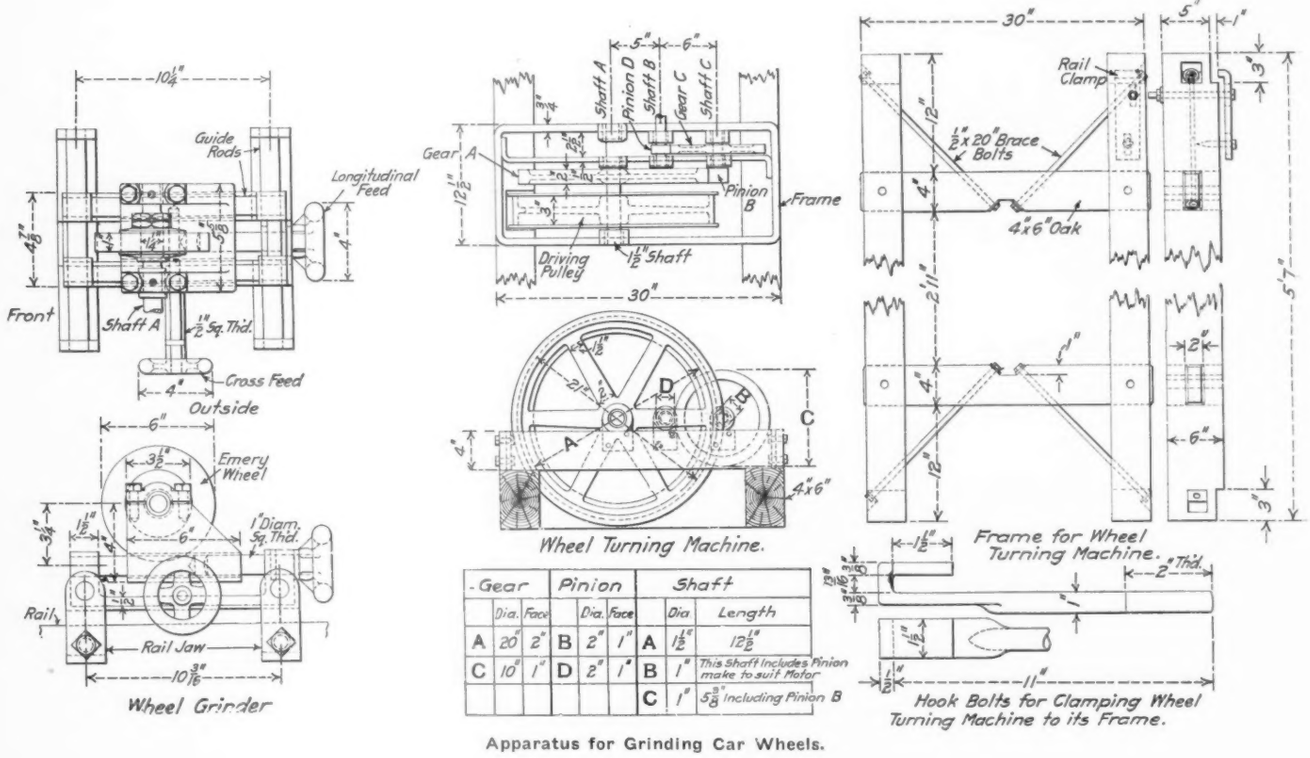


Details Used with Machine for Grinding Car Wheels.

The machine may be set up and operated by one man. It is first necessary to jack up the end of the truck on which the flat wheel is located, so that the axle is free to turn in its bearings; then block the wheels which are not to be ground, so as to eliminate as much vibration as possible. The axle pulley is then placed on the axle. This pulley has a cast iron band filled with wooden segments, *1*, *2*, *3*, etc.; a set of segments is required for each size of axle. Each set must fit the cast iron band, which is made in two pieces and bolted together.

The wheel turning machine is next set up. The frame of this machine is placed on the rails at a convenient distance from the axle pulley and is secured to the ball of the rail by the clamps shown; a clamp must be placed at each corner of the frame. The wheel turning mechanism is next placed on the frame so that the driving pulley will be in proper alinement with the axle pulley, and is clamped in position by four hook bolts. No holes are provided in the frame for the hook bolts, as there is no certainty as to the location of the machine, due to different types of brake rigging, etc. The necessary holes are bored after the machine is set up, and the axle and the driving pulleys are then connected by a belt 3 in. wide. Power for turning the wheels is supplied by a ½ h. p. electric motor connected to shaft *B* by means of a flexible connection. The grinder is next placed on the rail with the part marked "front" at the wheels, and the part marked "outside" at the outside of the truck. It will be noticed that this machine has a longitudinal feed of 3 in. and a transverse feed of 6 in. After it is placed within the limits of its longitudinal feed it is secured to the rail by the set screws in the rail jaws. The grinder is driven by a ¼ h. p. electric motor, which is flexibly connected to shaft *A*. This motor must have a separate frame and may be located to suit the operator.

The grinder should run at about 1,500 r. p. m. The operator has perfect control of the work by means of the two feeds. Care should be taken to grind both wheels to the same diameter, so as to preserve the good running qualities of the car. A wheel calliper is also illustrated, with which the size of the wheels may be taken accurately.



Gear			Pinion			Shaft		
	Dia.	Face		Dia.	Face		Dia.	Length
A	20"	2"	B	2"	1"	A	1½"	12½"
C	10"	1"	D	2"	1"	B	1"	This Shaft Includes Pinion make to suit Motor
						C	1"	5⅜" including Pinion B

Apparatus for Grinding Car Wheels.

LONG DISTANCE WIRELESS.—A message by wireless telegraph sent from Key West, Fla., recently was heard at Cairo, Egypt, about 7,000 miles away.

FIRES ON THE PENNSYLVANIA.—The Pennsylvania reports the smallest fire loss in thirty-four years. In 1908 the company's employees extinguished 274 fires out of a total of 1,397 which occurred on railroad property, and in 1912, 454 out of a total of 905. The steady increase in the efficiency of the fire fighting brigade was further developed last year by special training of employees and equipping additional locomotives in yard service with pumps. Including the fires to which city fire departments were called, the total loss was only $219,892 from the 905 fires.

GROWING COST OF FREIGHT CAR REPAIRS*

Some of the Principal Causes; Also Suggestions for Changes in Design, and Methods to Reduce it

BY F. F. GAINES,
Superintendent of Motive Power, Central of Georgia.

With the motive power of six to ten years ago, together with the size and the method of handling trains of that period, a wooden underframe of eight sills was considered a substantial design for freight cars; but the introduction of hump yards and the Mikado and Mallet type locomotives has revolutionized operating conditions, and where action has not been taken to bring the cars up to the required standard, it has resulted in an abnormal amount of repairs, particularly to the draft gear, center sills and end sills. Many railway officers have realized this situation and have provided at least steel underframes and high capacity friction gears on all new equipment. Some have been content with the steel underframe and a weak draft gear, while others have taken steps to reinforce the older wooden equipment with metal draft sills and friction gears, as well as to use the high capacity friction gears with steel underframes on all new equipment.

About two years ago a special analysis of repair bills was made on the Central of Georgia to see which were the principal items of expense so that measures could be taken to improve them. The analysis covered a period of six months, and in addition to itemizing repairs, the percentage of each item was shown for each railroad making repair bills against that company. The following table gives the average cost of the principal items in per cent. of the total bills:

Air hose	3.08 per cent.
Brake shoes	4.11 per cent.
Brasses	9.85 per cent.
Cleaning cylinders and triples	1.19 per cent.
Miscellaneous air brake repairs	5.13 per cent.
Wheels	9.70 per cent.
Axles	.39 per cent.
Oil boxes	.94 per cent.
Longitudinal sills	1.29 per cent.
Knuckle pins, locks, etc.	4.53 per cent.
Couplers	3.81 per cent.
Follower plates	.72 per cent.
Casements	.53 per cent.
Springs, draft	1.34 per cent.
Yokes	.30 per cent.
Yoke rivets and pocket bolts	3.56 per cent.
Draft timbers	1.76 per cent.
Draft bolts	28.37 per cent.
Carrier bolts	1.04 per cent.
Defect cards	6.27 per cent.
Miscellaneous	12.09 per cent.
Total	100.00 per cent.

Assembling all items connected with coupler and draft gear we have:

Follower plates	.72 per cent.
Casements	.53 per cent.
Springs	1.34 per cent.
Yokes	.30 per cent.
Yoke rivets and pocket bolts	3.56 per cent.
Draft timbers	1.76 per cent.
Draft bolts	28.37 per cent.
Carrier bolts	1.04 per cent.
Longitudinal sills	1.29 per cent.
Total	38.91 per cent.

This conclusively demonstrated the weakest spot and the one needing immediate attention. In rebuilding some wooden coal cars metal draft arms engaging the steel body bolster, and extending well back of the body bolster so as to reinforce the center sills at this point, were applied in connection with a substantial friction draft gear. These cars have been in service about three years without any cost for repairs of couplers or draft gears. One of them was in a collision on a foreign road and when returned had the eight longitudinal sills and the side planks broken, but there was no damage whatever between the center of the car and the ends, including the draft gear.

*Awarded first prize in the Car Department competition, that closed February 15, 1913.

The experience with this lot of cars, in connection with the analysis of the cost of repairs, resulted in a policy of improvement of all wooden underframe cars with an expected life of ten years or over. All such cars when requiring new center sills are equipped with the metal draft arms and a friction draft gear. In many cases where the center sills are only split by draft bolts the old sills are retained and metal draft arms are applied without the removal of the sills.

In designing new equipment the mechanical department of a railroad is in a much better position to do the work than the car builders. The latter are not familiar with operating conditions and approach the proposition from the standpoint of first cost, ease of construction, and with little or no concept of maintenance and repairs in ease of accident.

The function of any car is to transport its lading under normal conditions without damage to either the car or the lading, and with a minimum of weight per ton of lading. Box cars must be water and burglar proof. The design must also be economical as to maintenance. Normal conditions of today mean long, heavy trains handled by powerful Mikado and Mallet type locomotives, hump yards, and congested terminals where the equipment must stand collisions at speeds of ten to fifteen miles an hour without damage to the car, at least. That these conditions require a steel underframe has been so thoroughly demonstrated as to require no further proof. In the earlier types of steel underframe, in order to keep the light weight of the car in line with contemporary wooden construction, there was entirely too little material used. Its thickness was such that a few years' exposure to the elements caused serious corrosion and a further weakening of an insufficient design. The material was not distributed to the best advantage to resist the shocks incident to the service. Pressed shapes were largely used, which involved serious delays when heavy repairs due to accidents required new parts.

Today we know that we must put enough material in the underframe to take care of the service, and disregard the light weight of the car. Structural steel is in every way preferable to pressed shapes, even if the first cost is slightly greater. The thickness of members constituting the underframe should never be less than ¼-inch, and preferably 5/16-inch or over, to allow for corrosion. The center construction should be amply sufficient to transmit all shocks, jerks, etc. Whether in addition it should constitute the main carrying member or depend on the side framing for its portion is an open question, but in either event the fish belly type of center sill seems preferable. Eye-beams and channels, especially when not properly tied, do not fulfill the conditions required of them. There are in existence several thousand steel coal cars with channel center sills extending continuously from end sill to end sill, which even under service conditions frequently buckle back of the body bolsters, necessitating the cutting apart of the entire car to get them out for straightening or splicing. To eliminate such expensive repairs, underframes should be sufficiently strong between the body bolsters to withstand anything short of a heavy collision. The draft sills should be spliced ahead of the body bolsters so that in case of minor damage, repairs may be effected without dismantling the car. A heavy capacity friction draft gear is necessary to absorb as great an amount as possible of the blows delivered to it, and to transmit a minimum to the underframe.

On box and other house cars there should be at the end of

the frame a vertical member to which the end framing is attached, so that a shifting load will produce a shearing strain instead of tension at the bottom. Transoms, body bolsters and other members at right angles to the longitudinal axis of the car, should be flush with the side framing at the bottom. A slight side swipe that should do little more than scrape the side of the car, not even causing a derailment, will seriously damage transoms and body bolsters where they extend below the side framing, making an expensive repair job that could be eliminated by keeping them flush with the side framing.

A striking block of cast steel, integral with the underframe, to transmit the shocks to the center sills when the draft gear is solid, is another desirable feature. Various forms of carrier irons, which are easily removed when necessary to change couplers, as well as centering devices for couplers, are easily incorporated with this striking block. This arrangement prevents the driving in or pulling out of light end sills under service blows or jerks.

Trucks of substantial design are of varying detail. The tendency is to substitute steel castings for all or part of the truck side frame. Such castings, of proper design, which are well annealed allow of a better distribution of metal and the elimination of bolts and nuts that work loose and cause failure. Any one of several well known designs is entirely satisfactory from a maintenance standpoint. Cast iron wheels, well made, under lighter capacity cars have rendered a good account of themselves. For the heavier cars many wheel companies, at a slight increase in cost, are making special wheels that are equally efficient, and until we go beyond cars of 100,000 lbs. capacity, are enonomical and safe.

Hand brakes are frequently slighted in car design. The leverage should be such as to provide a good braking power without the use of clubs. A large percentage of damage to equipment and lading in terminal switching is caused by inefficient hand brakes.

Taking the three most generally used classes of equipment—box, flat and coal cars—there are some details of each about which there is a difference of opinion. A majority of the items for each, however, are pretty generally agreed on.

In box car design there is a question whether the superstructure should be composite or not. The composite type is expensive to repair in case of accident, generally requiring the dismantling of the entire superstructure. On the other hand, such a construction is probably cheaper to maintain against normal wear and tear. The end framing, at least, should contain a steel end plate securely fastened to the side plates, with steel corner posts, end posts and braces. The latter, in turn, should be secured to the steel end plate and the vertical flange of the underframe. At the belt rail a pressed steel fish belly girder extending across the end of the car and well anchored, in connection with the steel posts and braces, provides an end construction that will withstand almost any blow given by a shifting load. The same results are being accomplished by using an entire steel end with ribbing in concentric circles or horizontally to reinforce it.

The roof is the next item of importance, and is very frequently neglected. As a foundation, metal carlines should be used. Where the ends of the carlines are divided so as to form diagonal braces, they keep the superstructure from weaving. Metal carlines give a stronger body construction and more head room. There is a difference of opinion as to whether it is better to use an all-steel roof, an outside metal roof with wood underneath, or an inside metal roof with wood outside. The outside metal roof with wood underneath seems to have several advantages. The metal protects the wood from the weather and the wood acts as an insulation in hot climates. The inside metal roof with wood outside requires constant repairs to the wooden sheathing on account of the exposure.

Doors and fixtures are generally not of sufficient strength. Instead of the usual wooden door stop to which a staple is secured for sealing, it is much better to use a malleable casting for that part of the stop that carries the staple, with short strips of wood above and below it. The sealing apparatus can be made integral with the stop and is burglar proof. The hasp on the door, instead of being secured by a clip with one or two bolts, should be locked into a wrought strap extending at least half the width of the door. This arrangement not only makes the hasp burglar proof, but prevents tearing off the front section of the door, as the stress from the hasp is distributed the length of the wrought strap, or half the width of the door. The hangers should be of substantial design and well bolted to the door. The door track should be of ample cross section to support the door without deflecting, and should be well secured to the side plate. The chafing iron at the bottom of the door should be not less than 2 inches wide, bolted, not screwed, to the door, with substantial malleable castings at each end to protect it and act as guides. There should be a sufficient number of bottom guides so that, whether open or shut, the door will engage two of them, and preferably three, when shut. Probably a better lock and one which is more of a protection to the door, is one applied to the rear of the door. When flush doors are used, a type without a bottom track should be selected, as the bottom track is frequently bent by drays backing up to load or unload, and when the track is bent the door is either inoperative or hard to move.

In flat car design about the only open question is the kind of material for the floor. Metal floors for many loads are not desirable, and as long as oak can be obtained at reasonable prices it makes the most desirable arrangement. Yellow pine does not stand exposure to the weather and requires frequent renewal. Hand brakes with demountable or telescoping shafts are desirable on account of overhanging loads, which cause frequent damage to the ordinary type of brake shaft.

Coal cars, as a rule, should be all-steel. The composite car of the hopper type has proved expensive to maintain, and the all-steel gondola is less expensive to maintain than the one with wooden sides and floor.

While it is true that altered operating conditions have made the general design of the car of six or more years ago an expensive car to maintain in its original condition, it is possible to remove the largest single item of upkeep by using friction draft gears, and, when of wooden underframe, by the addition of metal draft arms. On the other hand, there are in service many cars designed in substantial accord with the foregoing suggestions and only requiring renewals of wearing parts, with a minimum expense for repairs in case of accident. With the gradual retirement of the older equipment there should eventually come a decrease in maintenance costs.

In conclusion, it seems only fair to claim that the mechanical officials have been somewhat unjustly maligned in some quarters, and that they are in close touch with the situation and are taking the necessary action to remedy it.

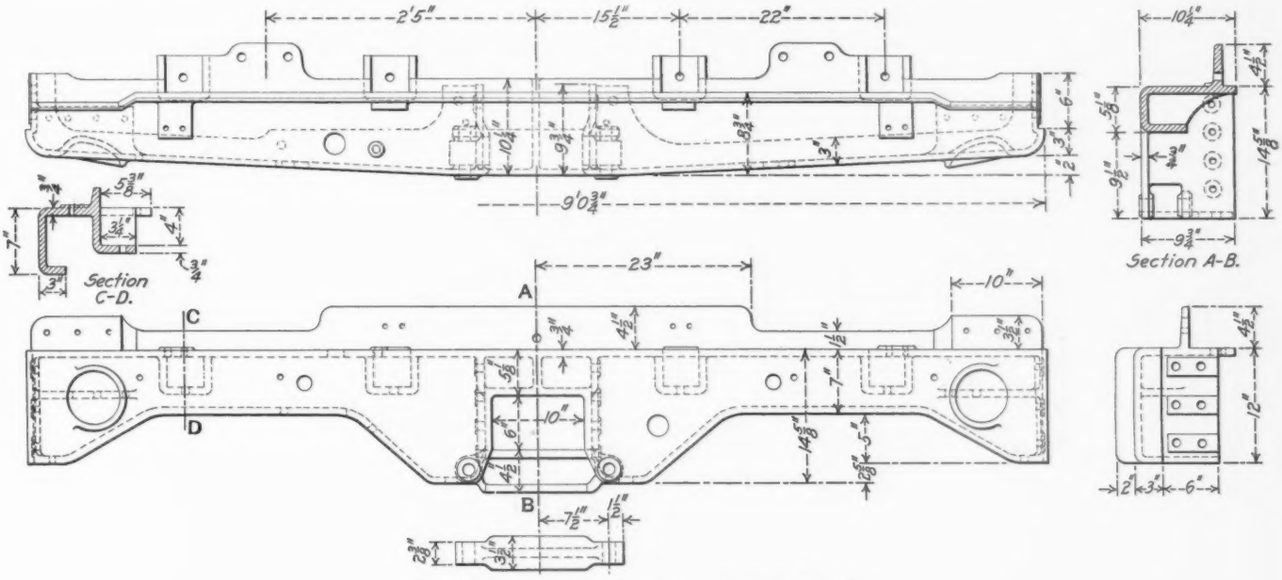
Forest Fires.—The Department of Agriculture reports that the losses by fire in the national forests during the year 1912 were lower than for many years. The total is estimated at $75,290. The aggregate number of acres burned over was 230,000 as compared with 780,000 acres in 1911.

Railway Improvements in the Netherlands.—A new railway line is soon to be constructed from Hoogeveen, in the province of Drenthe, to Ommen, in the province of Overysel. The distance is only 15 miles, but the new line will traverse a territory without railway facilities at present. This section is a great peat district. The railroad yards at Hoogeveen will be enlarged to meet the wants of the new line. Another important improvement in that region, soon to begin, is the double-tracking of the line between Hoogeveen and Groningen via Meppel, about 55 miles, coupled with enlargement of railway yards at several towns along the line.

FIFTY-TON LOW SIDE GONDOLA

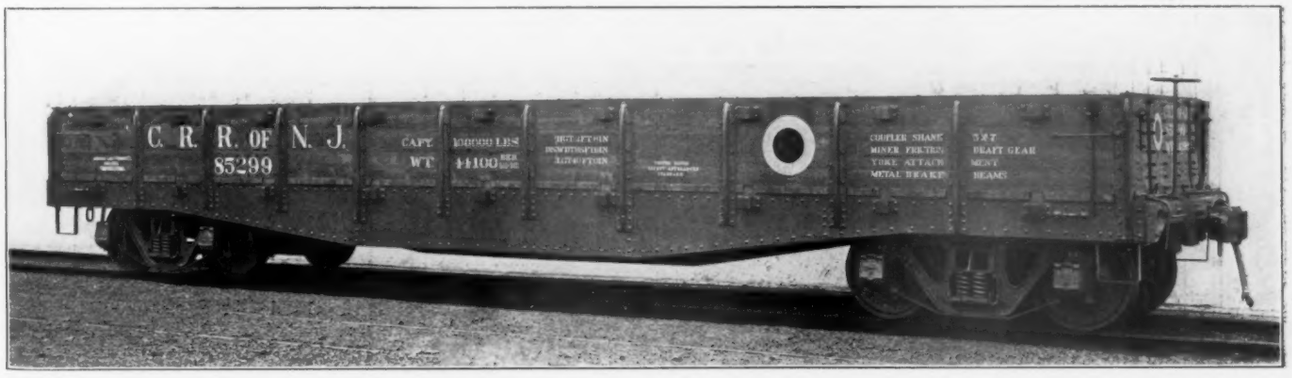
Substantial Steel Underframe, Forty Foot Car, with Drop Ends, for the Jersey Central

The design of the latest steel underframe, low side gondola cars, one thousand of which have recently been put in service on the Central Railroad of New Jersey, is based on a long experience with a large number of the same type. It probably represents the most approved practice for this particular class of equipment for the conditions existing on this railway. These cars are 42 ft. in length over the end sills and 40 ft. long inside of the body. They are arranged with drop end doors and safety chains for the handling of long material, and are designed to carry a concentrated load of 110,000 lbs. at the center of the car. The centers of the trucks are 31 ft. 4 in. apart. The floor is of 2⅜ in. long leaf southern pine, and the sides are the same material, 3¼ in. thick. The end doors are of 3 in. oak backed with 3/16 in. steel plates. In all other particulars except the floor stringers, the car is steel throughout.



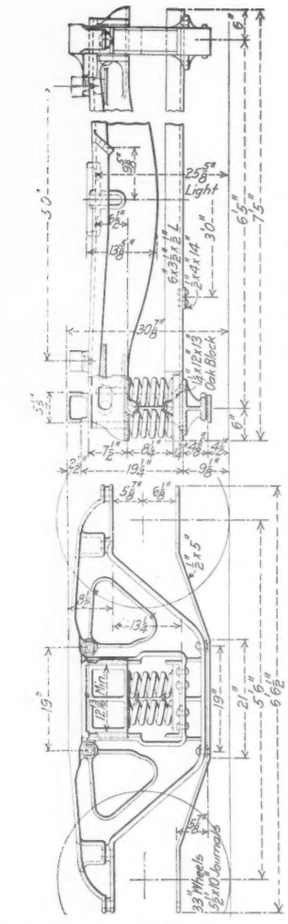
Cast Steel End Sills for Jersey Central Gondola.

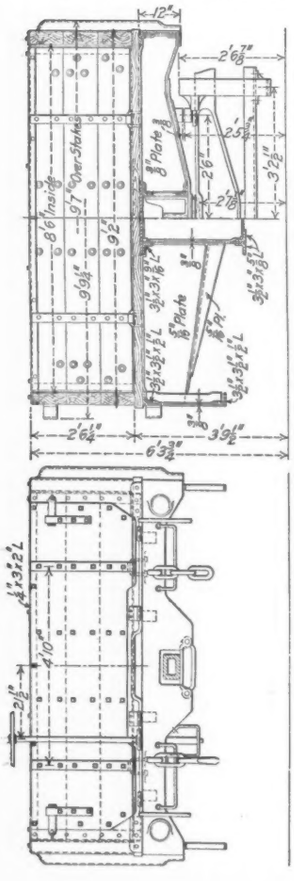
The underframe consists of a pair of fish belly center sills, each sill having a ⅜ in. web plate with an outside angle at the top and both outer and inner angles at the bottom. These sills have a depth of 30 in. over the angles for a distance of 11 ft. 2 in. at the center, and are 13½ in. deep at the bolster. There is a ⅜ in. top cover plate, 20¾ in. wide, running continuously for the full length of the car. The side sills are also fish belly type girders with a ⅜ in. web plate and angles on the inside at the top and bottom. These sills are 24 in. deep for a distance of 11 ft. 2 in. at the center. The web plates of the center sills terminate at a point just beyond their connection to the body bolster, but the top angles extend continuously to the end sills. The inside bottom angles of the center sills stop 6¼ in. behind the bolster and the outer angle at the bottom extends 20 in. beyond the bolster. The separate draft sills are formed from ⅜ in. plate pressed in channel shape and are spliced to the center sill web. There are inside and outside splice plates at this joint. The top angles of the center sills are also secured to the draft sills and the outer bottom angle is carried over the joint. The draft sills and side sills are secured to a cast steel end sill of the form and arrangement shown in the illustration. These sills were furnished by the Commonwealth Steel Company and are in one piece.

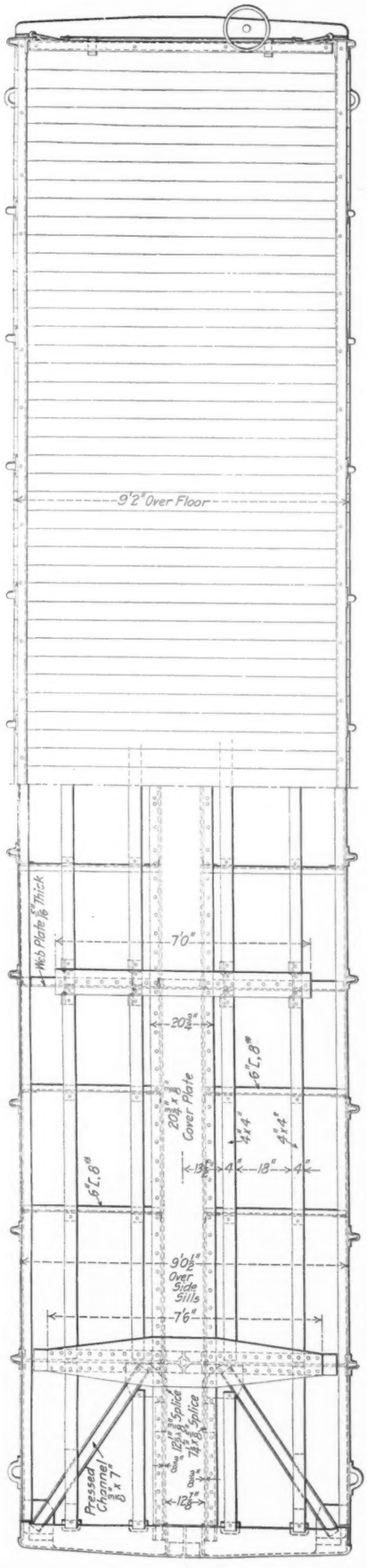


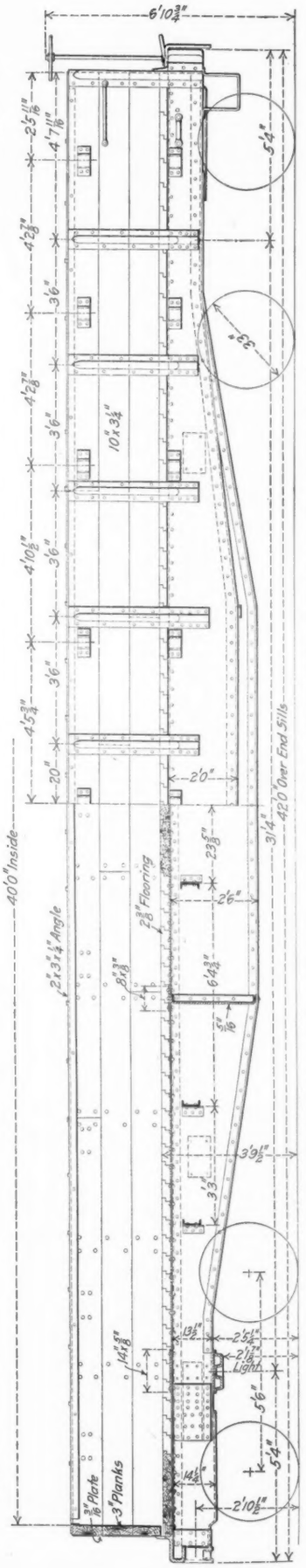
Steel Underframe Gondola Designed to Carry 110,000 Lbs. Concentrated at the Center of the Car.

The body bolsters are of the built-up design having double, pressed steel, channel shaped plates set back to back, a ⅝ in.









Plan and Elevations of Low Side, Drop End Door, Steel Underframe Gondolas for the Jersey Central.

top cover plate and a ½ in. bottom cover plate. The cross bearers are 5/16 in. pressed steel plate in channel section with a ⅜ in. x 8 in. top cover plate. These have a pressed steel channel reinforcement at the bottom, formed and applied as shown in the illustration. These cross bearers do not extend to the bottom of the center sills, but the filler sections between the center sills are arranged to extend the full depth. The cross ties, of which there are two between each of the cross bearers and the bolsters, are 6 in., 8 lb., channels secured to the side and center sills by ⅜ in. angles. The diagonal braces from the end of the side sills to the body bolster are pressed in channel shape from ⅜ in. plate. They are 5 in. in width and 1¾ in. in depth and are secured to the corner gusset plates at each end.

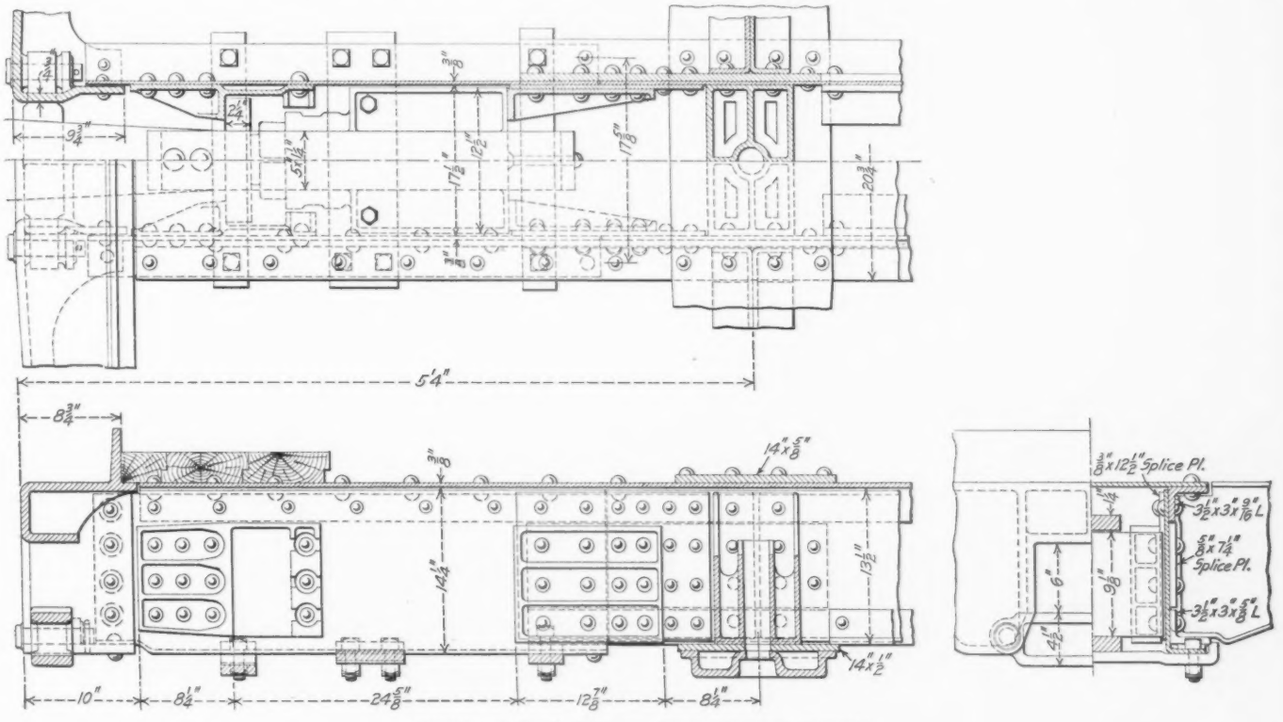
The wooden siding is bolted to side stakes pressed from ⅜ in. steel plate to the form and size shown in the illustrations. At the corners a special design of stake has been used which includes the stop for the sides of the end door. The part of this stake extending over the end, fits back of an extension on the top of the cast steel end sill. There is also an extension of this sill at the center of the car to reinforce the end door at the bottom and take the stress from the hinges. Pockets are provided for extra wooden side stakes where needed to carry a superimposed load. The sides are 2 ft. 6¼ in. high above the floor level and are capped by a 2 in. x 3 in. x ¼ in. angle iron. The flooring is nailed to four 4 in. x 4 in. yellow pine longitudinal sills which rest on and are secured to cross ties. These sills rest in malleable iron pockets at the cross bearers and bolsters, and in recesses in the end sills. The ends of the floor planks rest on top of the side sills and extend ½ in. beyond them.

The end doors have two hinges. The straps extend the full depth of the door and swing on a staple bolted in the end sill. The doors are held in a vertical position by a simple design of clamp on either side. There is a permanent hand brake at one end of the car only. This is located 21½ in. from the center line and passes through the end sill.

These cars are carried on trucks having a special improved Andrews cast steel side frame which is arranged with removable wearing plates at the openings for the bolster. The frames were furnished by the American Steel Foundries and have been somewhat strengthened at the point of support for the spring plank. Cast bolsters are employed and the wheels are of the 33 in. standard 725 lb. cast iron type. The journals are 5½ in. x 10 in., and Gould malleable iron journal boxes have been applied. Some of the specialties employed on the car are: Miner friction draft gear, class A-7; simplex couplers; Flory carry iron; Waycott brake beam and Westinghouse schedule K. C. 1012 brakes with No. 10 pressure retaining valves.

Five hundred of the cars were built by the American Car & Foundry Company, and an equal number by the Standard Steel Car Company. They have a total weight of 44,100 lbs. The general dimensions are as follows:

Length over end sills	42 ft.	0	in.
Length inside	40 ft.	0	in.
Distance from center to center of truck	31 ft.	4	in.
Width over side sills	9 ft.	½	in.
Width over auxiliary stake pockets	9 ft.	9¼	in.
Width over side stakes	9 ft.	7	in.
Width inside	8 ft.	6	in.
Height from rail to top of sides	6 ft.	3½	in.

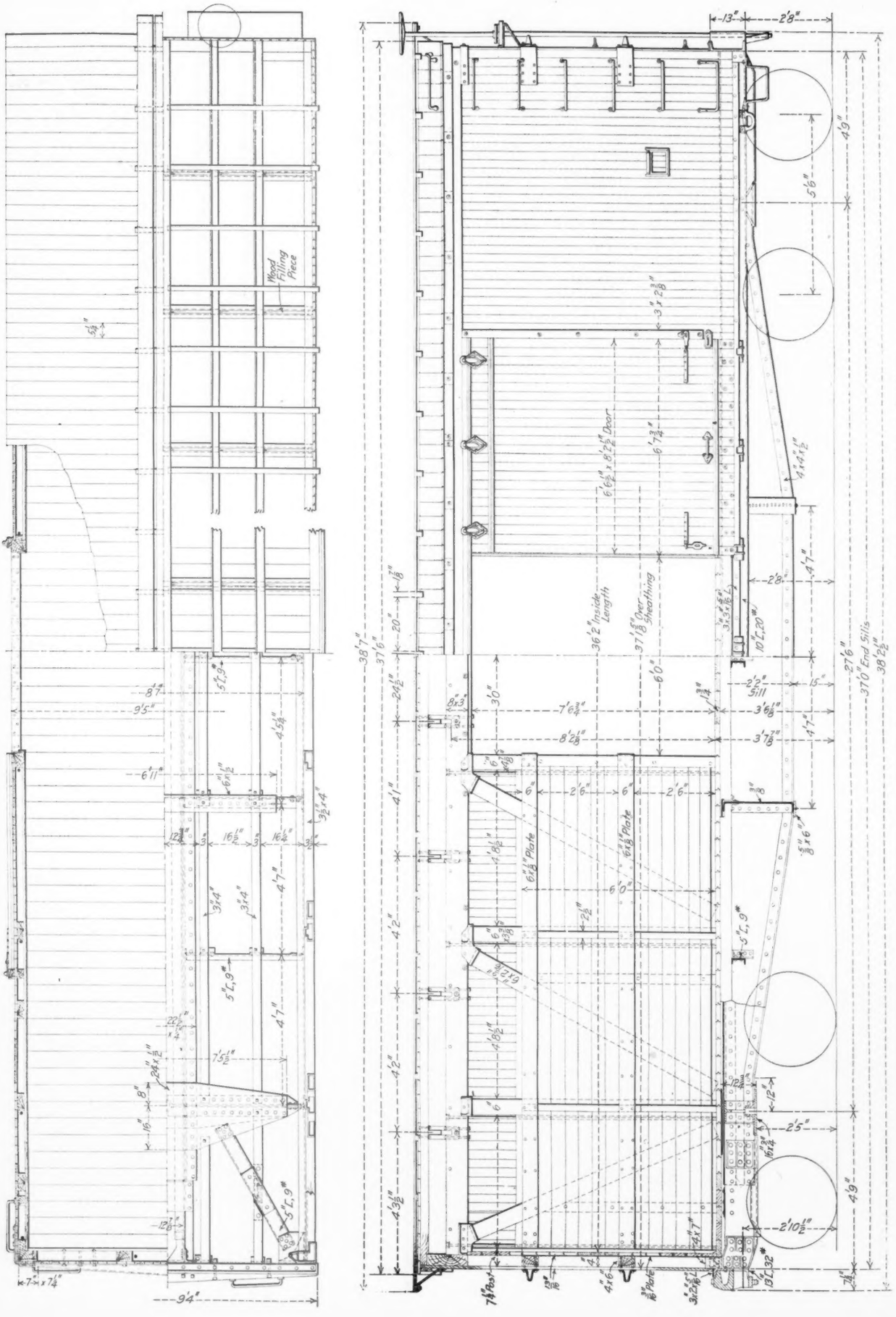


Details of Draft Sills on Jersey Central Gondola.

Height from rail to top of floor	3 ft.	9¼	in.
Height from rail to top of brake mast	6 ft.	10½	in.
Height from floor to top of car body	2 ft.	6¼	in.
Width over flooring boards	9 ft.	2	in.

Railroad to Connect Spain & France.—Construction work is under way on the Trans-Pyrenean Railway, which will connect Ax, in the southeastern corner of France, with Puigcerda and Ripoll, in the province of Gerona, in the northeastern portion of Spain.

Hydroplanes.—The advantages and disadvantages of hydroplanes are much the same as those of the ordinary aeroplane. Their main disadvantages are the difficulty of landing in a rough sea, and the fact that on alighting the supporting planes, etc., are liable to cause instability if there is much wind. They have, however, one great advantage over aeroplanes, viz., that they can be made larger and carry greater useful load, as they are not limited in space for starting. Improvements necessary, are as for aeroplanes, flexible give-and-take supporting surfaces and, further, suitable arrangements for folding up these surfaces when floating on the water.—*The Engineer.*

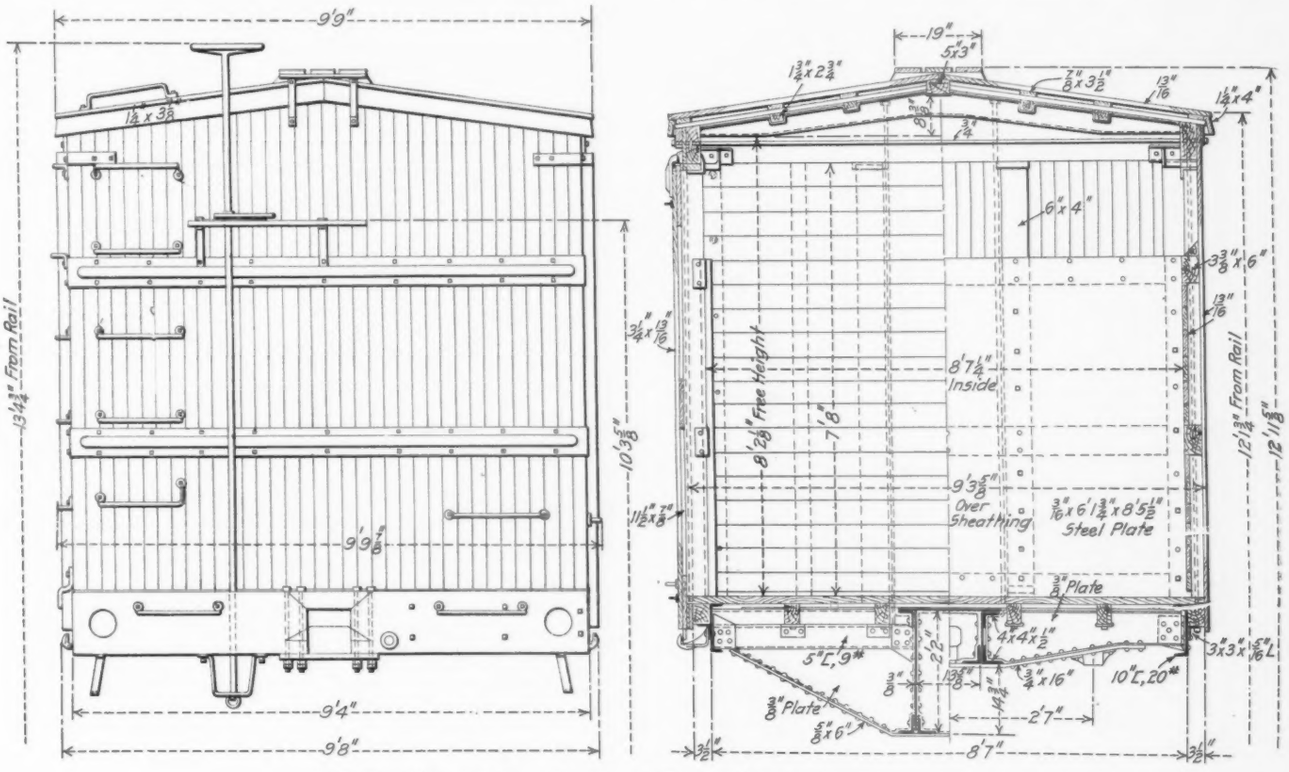

Wood Filling Piece
Inside Length
Over Sheathing
End Sills
Door
Plate
Steel Underframe Box Car with Reinforced End Construction; Philadelphia & Reading.

STEEL UNDERFRAME CAR FOR THE READING

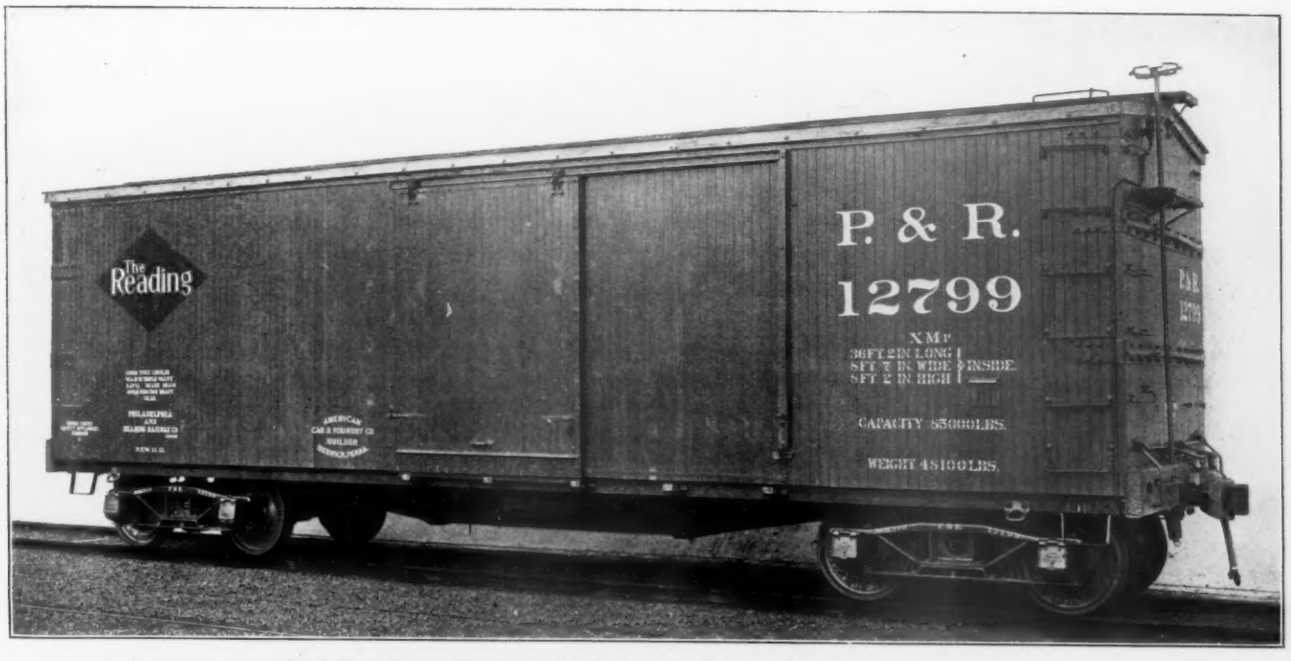
End Construction Reinforced by a Large Steel Plate, Heavy Cross Braces and End Sill Design.

The Philadelphia & Reading has in service nearly two thousand steel underframe, 85,000 lb. capacity box cars with a most substantial end construction. One thousand more of the same design are now being built by the American Car & Foundry Company. These cars have an inside length of 32 ft. 2 in., and the superstructure framing and sheathing is of wood with the exception of the carlines and several special steel reinforcing plates.

There is but little in the underframe design that differs from the usual modern practice. The center sills are built up of



End Elevation and Cross Section of Philadelphia & Reading Box Car.



Steel Underframe Box Car with Reinforced Ends; Philadelphia and Reading.

⅜-in. web plates, 26 in. in depth for a distance of 9 ft. 9 in. in the center, and 11½ in. in depth over the bolsters. These are reinforced at the top by a 4 in. x 4 in. x ½ in. angle on the outside, and at the bottom by inside and outside angles of the same size. There is a top cover plate ¼ in. x 22½ in. which runs continuous for the full length of the center sills proper, but does not include the draft sills. The side sills are 10 in., 20 lb., channels with the flanges turned inward, and have 3 in. x 3 in. x 5/16 in. angles riveted on the outside of the web for supporting the outside floor stringers. The construction of the cross bearers and floor beams is clearly shown in the illustrations. Special attention is directed to the bolster top cover plate, which is of ½-in. steel, 24 in. wide at the center, thus giving a liberal connection with the center sills and materially stiffening their short extension beyond the bolster. The draft sills are pressed in Z shape from ⅜-in. plate, and have lap joints on the webs of the center sills to which they are secured by 19 rivets, 9 of which are ⅞ in. The top cover plate of the center sills extends over this joint.

The construction at the end of the car offers the point of greatest interest in the design. The end sills are 13 in., 32 lb., channels, and are secured to the draft and side sills by substantial malleable iron connections and stiffeners. This channel extends several inches above the top level of the underframe, and has a 3 in. x 2 in. x 5/16 in. angle riveted to its top flange. The outwardly extending flanges of the sill enclose a cast steel filling block that includes the push pole pockets. Back of the top extension of the end sill is a 4 in. x 7 in. wooden sill, and back of this a 3/16 in. steel plate, which extends from the bottom of the floor boards to a height of 6 ft. 1¾ in. for the full width of the inside of the car. Outside of this plate are two 4 in. x 6 in. horizontal wooden members and two intermediate 4 in. x 6 in. end posts and the vertical 3/16 in. outside sheathing. The superstructure also includes a 3⅜ in. x 6 in. belt rail and an intermediate plate of the same size, both of which are reinforced on the inside by ⅛ in. x 6 in. steel plates. These are bent over at the end and riveted to the end reinforcing plate, and are secured with numerous screws to the wooden member back of them. At the opposite end they are bent over and secured to the door post. As a further reinforcement to the end construction there are two pressed steel end braces formed in U section, 4 in. deep at the center of the car and tapering in at the corners. These are 6 in. in width and are secured outside the sheathing and have an extension on the side of the car for 14¼ in. where they are bolted through the side framing to the steel reinforcing plates just mentioned.

The arrangement and construction of the wooden superstructure closely follows accepted practice for this size of car, and is clearly shown in the illustrations. An improved Chicago-Winslow inside metal roof supported by Chicago-Cleveland pressed steel carlines has been applied. It will be noted that the floor is supported by six longitudinal 3 in. x 4 in. stringers which are carried by malleable iron brackets at the cross braces and bolster, and rest on top of the floor beams. The cars weigh 48,100 lbs. new.

Parcels Post Record.—The postmaster general reports that the number of parcels carried in the mails during the month of February was about fifteen million, or 50 per cent. in excess of the number carried in January. The number mailed in Chicago was 5,167,540, more than a million greater than the number sent from New York, which showed the next largest record.

Aviation Record.—On Tuesday, February 25, a French aviator, Marcel G. Brindejonc des Moulinais, flying in a monoplane, traversed the distance from Paris to London, 287 miles, at the rate of about 90 miles an hour. There was a dense fog when he crossed the channel. The aviator started at 9:15 a. m., landed at Calais at 10:50, resumed his flight at noon, and descended in London at 1:30.

ILLUMINATION OF POSTAL CARS

The lighting of postal cars, because of the character of the work performed in them and the length of time that artificial light is required, is a subject which requires very close study and attention. The Baltimore & Ohio, through its electrical department, made an extensive series of tests during the fall of 1912 in Washington, D. C., on one of its latest types of steel postal cars, in order to obtain adequate data on this subject. The standardization of the construction and of the arrangement of this type of car makes it possible to draw conclusions from these tests that will generally apply to cars built under the present government specifications.

Although the tests were carried out on a broad engineering basis, covering all practicable methods of car illumination available at the present time, the investigation was confined solely to the question of providing proper and adequate illumination. The questions of maintenance, of the most desirable kind of illuminants, and of the operating problems connected with the generation of light were not considered further than with respect to their influence upon the quality of illumination provided. In detail, the phases of the subject covered were the relative suitability of: first, Pintsch gas and electricity, representing the most important types of primary illuminants, as far as their influence upon the quality of illumination produced was concerned; second, the different types of reflectors and diffusers; and third, the different types and arrangements of lighting units. The investigation consisted of illumination tests to ascertain efficiency and uniformity data as well as shadow effects obtained with the various types of lighting units and spacing arrangements; also, visual intensity tests to ascertain the intensities of illumination required in the different sections of the car by the character of the visual work performed in those sections.

Two important features brought out by the investigation were: that adequate illumination may be provided with the amount of light that is at present generally provided by most railroads, the unsatisfactory illumination frequently obtained being largely due to the improper arrangement of the light units and unsatisfactory types of reflectors; and that the amount of illumination required for the work in the postal service has been considerably over-estimated.

In the direct system of illumination the correct location of the light is determined by absence of the shadows. In the bag rack section of the car the light units should be located along the center line of the car and the mounting height should be 7 ft. 7 in. from the floor to the center of the lamp filament or gas mantle in order to produce the least objectionable shadow effects as well as to eliminate shadows on the rear bag rack label. At the letter cases adequate illumination can be provided for only by light units independent of those used for illumination of the body of the car, and such light units should be located as far in front of the case as possible without shadows being thrown on the work by the body of the mail distributor. With the standard design of letter case having a 17 in. table this distance is 20 in. from the front of the letter case.

In determining the best types of reflectors for postal car service four qualities were considered: the effect of the resultant illumination upon the eye; the relative efficiency; the cleaning consideration; and the liability to breakage. As these are not of equal importance, relative values of these qualities were chosen after considering the question from several different points of view. Out of a total of 100 points an importance represented by the following figures was assigned to each of the qualities under consideration:

Effect on the eye	44
Efficiency	30
Cleaning	18
Breakage	8
Total	100

On this basis the relative suitability of the various types of reflectors for postal car lighting was found to be as follows:

Class of Reflector.	Make of Reflector Represented in Tests.
Aluminumized metal	Holophane D'Olier No. 18460 body of car; Holophane D'Olier No. 18470 at letter case.
Heavy density opal glazed reflecting surface (specially designed for car lighting service)	Holophane No. 18626 redesigned.
Medium density opal glazed reflecting surface	Phoenix CL-50.
Porcelain enameled metal	Holophane D'Olier No. 18461.
Medium density opal depolished reflecting surface	Macbeth-Evans Alada No. SF-1623.
Indirect lighting with enameled reflectors for gas lighting	Experimental enameled reflector.
Mirrored glass (direct lighting)	X-Ray 555.
Prismatic clear	Holophane No. 18226.
Prismatic satin finish	Holophane No. 18226-SF.
Reflecting and diffusing globes	Safety Corona No. 8026.

Extensive tests to determine the amount of illumination required for comfortable reading indicated that there was an appreciable difference in the character of the illumination afforded by different types of equipment. Certain types gave an illumination of such a character as to leave the eye in a less satisfactory condition for vision, thus requiring an increased intensity of

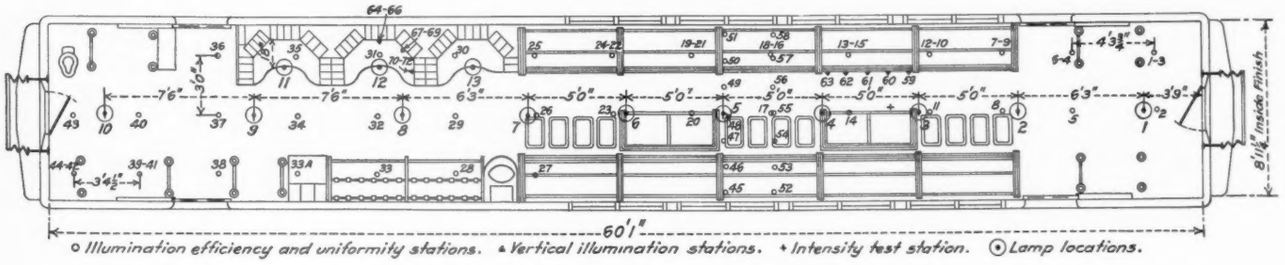
A SUMMARY OF THE BALTIMORE & OHIO ILLUMINATION TESTS.

Installation.	Entire Car.			Bag Rack Section.			Letter Case Section.		Storage Section.
	Nature of Value.	Foot candles.	Per Cent. Useful Lumens.	Ft. C. Center of car.	Ft. C. Mouth Bags.	Ft. C. Vertical on Pap. Bx.	Horizontal Ft. C.	Vertical Ft. C.	Foot candles.
Mirrored glass, X-Ray 696, 5 ft. spacing, 1 3/16 in., position	Avg.	6.03	62.3	12.04	3.77	3.74	10.75	4.67	3.84
	Max.	17.90	....	17.90	3.98	4.74	13.70	7.04	8.90
	Min.	2.12	....	7.28	3.37	2.16	8.80	2.72	2.12
Prismatic clear, Holophane 18226, 5 ft. spacing, 1⅜ in. position	Avg.	5.28	54.6	8.38	3.45	1.95	7.87	4.48	3.65
	Max.	14.65	....	9.36	3.69	2.46	9.52	6.67	6.76
	Min.	2.02	....	7.72	3.20	1.59	6.42	2.01	2.02
Prismatic clear, Holophane 18226, 7½ ft. spacing, 1⅜ in. position	Avg.	3.97	53.4	6.13	2.47	1.17	6.94	4.48	2.92
	Max.	11.30	....	8.39	3.40	1.60	7.67	6.67	8.00
	Min.	.89	....	4.79	1.97	.97	6.14	2.01	.89
Heavy density opal, Holophane 18626, 5 ft. spacing, 1⅜ in. position	Avg.	5.00	51.8	8.33	3.59	2.75	7.69	5.05	3.42
	Max.	11.55	....	10.38	3.93	4.06	9.03	8.54	6.46
	Min.	2.09	....	7.66	3.26	1.91	6.17	2.27	2.09
Heavy density opal, Holophane 18626, 7½ ft. spacing, 1⅜ in. position	Avg.	4.20	56.4	5.87	2.76	1.74	7.83	....	3.04
	Max.	12.52	....	9.49	3.76	3.35	9.79	....	8.83
	Min.	1.03	....	4.63	2.38	.98	6.51	....	1.03
Medium density opal, Phoenix 10456, 5 ft. spacing, 1⅝ in. position	Avg.	4.14	42.8	6.31	3.43	4.01	5.36	3.01	2.96
	Max.	8.45	....	7.62	3.72	4.65	5.72	5.09	5.50
	Min.	2.14	....	5.71	2.91	3.19	4.78	1.22	2.14
Prismatic satin finish, Holophane 18226 SF, 5 ft. spacing, 1⅜ in. position	Avg.	3.78	39.0	6.07	2.89	2.52	5.51	3.16	2.74
	Max.	7.95	....	6.87	3.13	3.08	6.14	5.10	4.73
	Min.	2.09	....	5.36	2.51	1.99	4.95	1.46	2.09
Aluminumized metal, Holophane D'Olier 18460 and 18470, 5 ft. spacing, 1⅜ in. position	Avg.	4.28	44.2	5.86	3.35	2.66	8.42	3.95	3.03
	Max.	9.51	....	6.14	3.57	3.69	9.51	5.86	5.19
	Min.	2.39	....	5.58	2.96	1.35	7.13	2.23	2.39
Aluminumized metal, Holophane D'Olier 18460 and 18470, 7½ ft. spacing, 1⅜ in. position	Avg.	3.38	45.3	4.37	2.50	1.46	7.64	3.95	2.43
	Max.	8.84	....	5.21	2.83	3.38	8.84	5.86	4.50
	Min.	1.15	....	4.02	2.23	.58	6.87	2.23	1.15
Medium density opal, Macbeth-Evans SF-1623, 5 ft. spacing, ⅝ in. position	Avg.	3.98	41.1	5.84	3.39	3.34	5.19	3.31	2.96
	Max.	7.85	....	6.65	3.68	4.20	5.54	5.90	4.90
	Min.	2.38	....	5.43	2.86	2.51	4.71	1.45	2.38
Medium density opal, Macbeth-Evans SF-1623, 7½ ft. spacing, ⅝ in. position	Avg.	3.10	43.0	4.26	2.45	1.89	4.46	3.31	2.36
	Max.	6.76	....	6.02	3.12	3.18	4.83	5.90	4.46
	Min.	1.32	....	3.65	2.25	1.25	4.04	1.45	1.32
Enameled metal, Holophane D'Olier 18461, 5 ft. spacing, 1⅜ in. position	Avg.	3.86	39.9	5.78	3.12	2.85	5.62	4.09	2.74
	Max.	8.17	....	6.80	3.26	4.04	6.21	7.17	5.32
	Min.	1.67	....	5.48	2.76	1.75	4.77	1.56	1.67
Enameled metal, Holophane D'Olier 18461, 7½ in. spacing, 1⅜ in. position	Avg.	3.23	43.4	4.39	2.38	1.47	5.44	4.09	2.52
	Max.	7.94	....	6.70	3.00	2.97	6.31	7.17	5.42
	Min.	1.26	....	3.68	2.08	.80	4.67	1.56	1.26
Heavy density opal, Opalux 123, 5 ft. spacing, 1 3/16 in. position	Avg.	3.73	38.5	5.51	3.14	4.27	4.98	3.63	2.84
	Max.	7.00	....	6.15	3.36	5.52	5.26	6.60	5.33
	Min.	2.11	....	5.07	2.58	2.83	4.65	1.34	2.11
Medium density opal, Phoenix CL-50, 5 ft. spacing, 1⅜ in. position	Avg.	3.81	39.4	5.54	3.12	2.63	5.11	3.46	2.87
	Max.	7.92	....	6.30	3.28	3.14	5.68	.58	5.11
	Min.	1.75	....	5.13	2.57	2.13	4.45	1.46	1.75
Reflecting and diffusing, Adams & Westlake 15050, 5 ft. spacing	Avg.	3.06	31.6	4.79	2.45	4.14	4.34	....	2.18
	Max.	5.63	....	5.42	2.85	4.51	4.78	....	4.56
	Min.	1.21	....	4.32	2.16	3.63	3.82	....	1.21
Bare lamps, 5 ft. spacing	Avg.	2.71	28.0	3.79	2.46	4.36	2.72	1.94	2.10
	Max.	5.20	....	4.11	2.84	4.59	2.93	3.86	3.69
	Min.	1.65	....	3.42	2.00	4.14	2.56	.59	1.65
Aluminumized metal, Holophane D'Olier 18440, 5 ft. spacing, "O" position, 15 watt lamps	Avg.	2.28	44.6	3.63	2.10	2.34	2.28	1.69	1.62
	Max.	4.15	....	3.96	2.23	3.54	2.71	3.05	2.77
	Min.	.38	....	3.32	1.99	.98	1.50	.57	.58
Mirrored glass (indirect lighting), X-Ray E-100, 50 watt lamps, 10 ft. spacing	Avg.	2.37	26.1	3.34	1.82	1.46	1.90	1.49	2.05
	Max.	4.26	....	3.87	2.24	1.78	2.18	1.99	4.26
	Min.	.84	....	2.89	.84	1.14	1.58	.95	.93
Gas Lighting.									
Aluminumized metal, Holophane D'Olier 18418 and 18490, mantle 3044, 7½ ft. spacing	Avg.	5.95	44.5	7.24	4.07	2.30	15.4	6.08	4.78
	Max.	17.10	....	7.96	4.59	5.16	17.10	8.90	8.33
	Min.	2.47	....	6.51	3.65	.93	12.55	3.69	2.97
Enameled metal, Holophane D'Olier 18417 and 18479, mantle 3044, 7½ ft. spacing	Avg.	4.91	37.2	6.66	3.72	3.78	9.40	6.32	4.24
	Max.	11.88	....	7.37	4.06	8.90	11.88	11.80	7.78
	Min.	2.29	....	5.60	3.13	1.60	7.12	2.59	2.74
Aluminumized metal, Holophane D'Olier 18410 and 18490, mantle 3044 and 2640, 7½ ft. spacing	Avg.	4.88	45.0	5.61	4.01	4.54	11.22	5.15	3.92
	Max.	13.50	....	6.26	4.47	9.18	13.50	7.51	5.48
	Min.	2.78	....	4.52	3.09	2.03	9.63	3.05	2.92
Reflecting and diffusing globe, Safety Corona 3425, mantle 3044, 7½ ft. spacing	Avg.	4.10	30.7	5.47	3.47	5.26	5.20	5.04	3.46
	Max.	7.80	....	6.79	6.00	6.26	5.83	8.85	6.23
	Min.	2.04	....	4.59	2.63	4.60	4.67	1.89	2.04
Reflecting and diffusing globe, Safety Corona 8026, mantle 3044, 7½ ft. spacing	Avg.	3.86	28.9	5.18	2.85	4.56	5.56	4.05	3.37
	Max.	8.23	....	5.95	3.23	6.05	6.22	6.60	6.20
	Min.	2.00	....	4.25	2.42	3.72	4.83	1.93	2.00
Diffusing globe (opal), Safety 3116, mantle 3044, 7½ ft. spacing	Avg.	3.27	24.0	4.58	2.19	3.48	5.59	3.20	2.79
	Max.	6.81	....	5.63	2.63	4.73	5.94	4.94	5.79
	Min.	1.50	....	3.52	1.84	2.80	5.41	1.69	1.50
Enameled metal (indirect lighting), Safety mantle, "125 C. P.," 10 ft. spacing	Avg.	2.06	18.9	3.13	1.70	1.36	1.38	.77	1.95
	Max.	3.35	....	3.34	2.20	1.56	2.02	1.03	3.14
	Min.	.90	....	2.88	1.13	1.19	1.04	.51	.90

illumination for adequate vision. For practical purposes it was found that with direct lighting systems the equipment could be divided into two classes relative to the character of illumination produced; one in which the specular element was considerable, such as was obtained from direct lighting systems employing mirrored glass, porcelain enameled, heavy density opal-reflectors with glazed reflecting surface; and one in which the illumination was largely diffused, such as was obtained from direct lighting systems using diffusing globes, opal reflectors of all classes except heavy density opal with a glazed reflecting surface, aluminumized metal, and prismatic reflectors. This class of reflectors required approximately 80 per cent. of the illumination of the first class. Extensive tests made to ascertain the intensities of illumination required showed that 2.25 foot candles as to render the eye much less efficient as well as more susceptible to severe eye strain than where reflectors are used.

The minimum and maximum initial illumination values, as well as the service illumination values required under the Post Office Department specifications, revised to December 28, 1912, were determined upon as a result of these tests in this connection, and they constitute the only authentic data thus far available on this subject.

So far as the question of illumination is concerned the investigation showed that when proper location of lamps and proper types of reflectors are provided, equally satisfactory results may be obtained with Pintsch mantle gas lighting and electric lighting. In conducting the tests the assistance of illuminating experts of the leading reflector, car lighting fixture, and in-



Location of Stations and Lamps with 5-ft. Spacing.

on the reading plane was a safe value for minimum satisfactory intensity for continuous close visual work under illumination derived from lighting units of the second class. On the same basis it was found that 3.5 ft. candles was ample illumination and that higher values were unnecessary for adequate service. It was further found that about one-half or slightly less of this minimum intensity value was required at the mouth of mail bags in the bag rack portion of the car, on the face of the letter cases and in the storage section. The results of the illumination tests with the principal types of electric and gas units tested are given in the accompanying table, while the two illustrations show the plans of the test car giving the location of the lighting units and of the test stations. The table gives the average, maximum and minimum foot candle values obtained in the car as a whole, the bag rack section, the letter case section and the storage section. The efficiency of the system is given as the ratio of light falling on the working plane to the total light generated by the lamps.

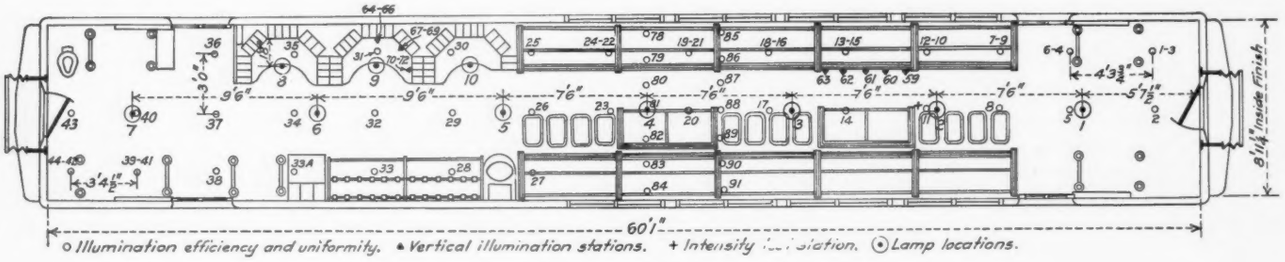
The importance of using proper types of reflectors in car lighting service for all classes of cars is shown in the comparison of the illumination obtained with the most efficient type of reflector tested, the mirrored glass, with the bare lamps, in which the illumination obtained on the working plane where the reflector was used was practically 220 per cent. of that obtained with the bare lamps, the number of lamps installed being the same in each case. The ceiling of the car had been freshly painted a dead white, which gave more favorable conditions for the bare lamps than would generally be obtained in service. Further, the glare effect obtained from the bare lamps is such

candescent lamp manufacturers was obtained, and in order to insure the greatest accuracy of the test results the National Bureau of Standards extended its co-operation by calibrating the instruments, rating the lamps used, and making photometric curves of all the light units tested.

Acknowledgment is made by the railway company to the Holophane Works of General Electric Company, Safety Car Heating & Lighting Company, Adams & Westlake Company, National Electric Lamp Association, General Electric Company, Westinghouse Lamp Company, Macbeth-Evans Glass Company, National X-Ray Reflector Company, Phoenix Glass Company, Opalux Company, and the National Bureau of Standards for their co-operation in conducting this research.

Progress at Panama.—The total excavation for February was 2,108,530 cu. yds., place measurement, against 2,612,020 cu. yds. in January.

South African Railways.—The report for 1911 of the general manager of the South African Railways and Harbours states that at the end of the year the open mileage was 7,546½ miles, while about 913 miles were under construction. The earnings were 12 million pounds sterling, including over two millions from coal, and the expenditure £7,217,000, the surplus being £4,887,000. The results obtained from two locomotives built at Durban have convinced the chief mechanical engineer that the policy of building locomotives and boilers in the Durban and Salt River workshops should be considerably extended as soon as these shops have been enlarged.—*The Engineer.*

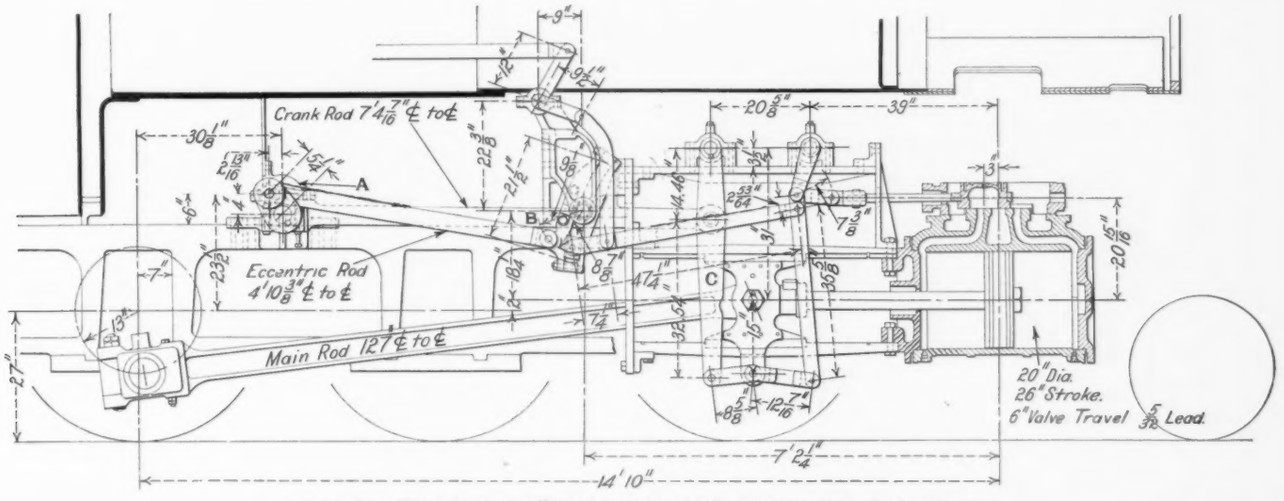


Location of Stations and Lamps with 7½-ft. Spacing.

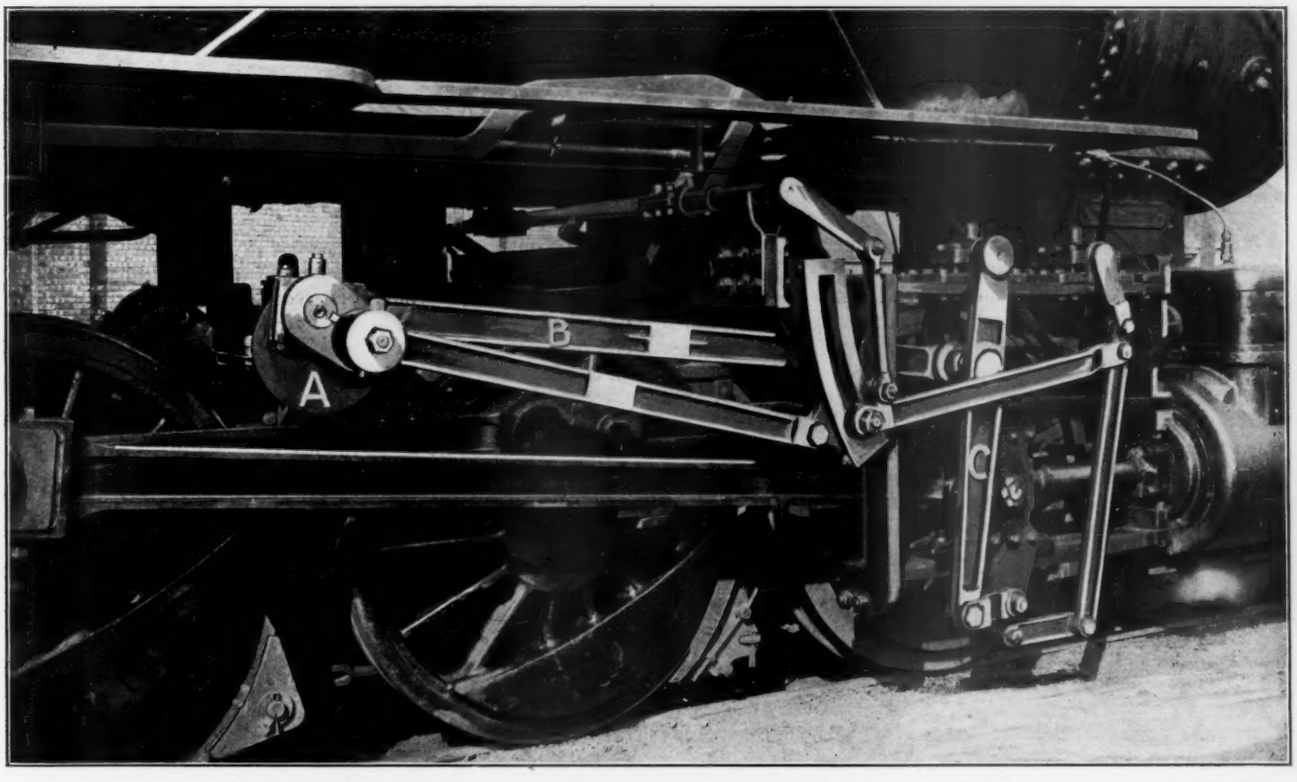
NEW DEVICES

LOCOMOTIVE VALVE GEAR DRIVEN FROM THE CROSSHEAD

The rolling of a locomotive changes the relative position of the driving axle and the cylinders and has some effect on the accuracy of the Walschaert and Stephenson type of valve gears. For the purpose of overcoming this objection, an original type of valve gear has been designed and put in service on the Chicago, Peoria & St. Louis. It consists essentially of a Walschaert gear deriving its motion for the valve travel from a return crank on a revolving shaft fastened to the locomotive frame, instead of from the driving wheel in the customary manner. This driving shaft, which is marked *A* in the illustration, continues across the locomotive on top of the frames and is revolved by the lever *C* and the rod *B* which form a connection from the crossheads as shown. It thus has practically the same rotary motion as the driving wheel and the movement of the return crank delivers to the link the same speed and periodicity of oscillation as it would have if connected to the driving wheel. It should be noted, however, that the rotary shaft on the engine



Valve Gear That Is Not Affected by the Vertical Movement of the Drivers.



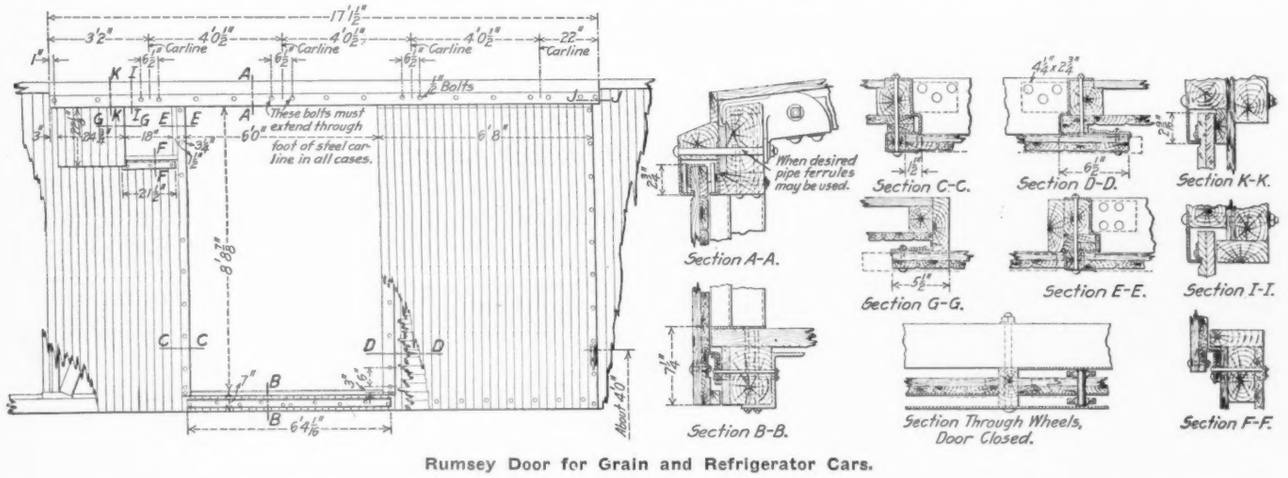
Locomotive Valve Gear Driven from the Crosshead; Chicago, Peoria & St. Louis.

is rigidly supported from the frame the same as the link, and their relative positions are therefore unchanged and unaffected by any vertical movement of the wheels and boxes in the pedestals. The eccentric or return crank is of the same general form and performs the same functions as in the ordinary Walschaert valve gear.

This valve gear has been applied to a Chicago, Peoria & St. Louis locomotive which was built to carry 200 lbs. steam pressure and it is reported that since applying the new gear the pressure has been reduced to 180 lbs. without reducing the efficiency of the locomotive. This is believed to be due to the more accurate and uniform movement of the valve.

RUMSEY FREIGHT CAR DOOR

A freight car door, designed to meet the requirements of all kinds of freight service, has been placed on the market by the Rumsey Car Door & Equipment Company, Karpen Building, Chicago. At the first glance this door has all the appearances of the ordinary car door now in use on most roads. In fact, the design of the door itself is secondary to the design of the door housing in the side of the car. It has been the aim of the makers to so design the door and door opening that when the door is closed the opening will be as thoroughly protected and as substantial as any other part of the car.



Rumsey Door for Grain and Refrigerator Cars.

The chief difficulties experienced with freight car doors in general have been encountered when shipping grain, flour, etc., in bulk, or the ease with which they may be sprung open for unwarranted entry. This door is so designed that when closed it has a positive bearing on all four sides, and is so anchored in the side of the car that any attempt to force an opening, without breaking the seal, is practically impossible. The first feature eliminates the cooperage work necessary on old type doors, which at best is usually unsatisfactory, and the second feature will materially reduce the amount of the claims paid for stolen freight.

The door is made of two layers of boards, the inner layer running longitudinally with the door action. It is carried by two pairs of rollers running on pressed steel tracks bolted to the side plate, as shown in section *AA*. The axles of the rollers have a force fit in the stiffening angle. When the door is closed it will be forced to a bearing, on the top, against the edge of the inside door track. Section *BB* shows clearly the bottom guide. Both the guide on the door and on the car are of pressed steel; the guide on the car is securely bolted to the side sill. The block or filler attached to the door underneath the guide is to prevent the guides from being damaged by any vehicle backing up against the door.

The design of the door post, which is one of the important features of the construction, is shown in section *CC*. A pressed steel shape encases and is securely bolted, or riveted in steel cars, to the main post and forms the pocket for the door. The outer end of the pocket is slightly bent outward so that when the door is closed it will be forced to a positive bearing against the inside face of the pocket, thereby forming a seal against any leakage of the material within, and against any moisture from without. The notch cut out of the filler block in the pocket is to allow any moisture that may collect to escape. The other end of the door is similarly forced against the door framing, as shown in section *DD*. By means of these guides the door is made to bear on all four sides of the framing. The right hand door post is also encased by a pressed steel shape which not only protects the wooden post, but also gives a much stiffer and durable arrangement.

Special efforts have been made to make the door water proof when it is closed, and a study of the construction will show that every means has been adopted to keep the water or moisture out. Where there is a possibility for any moisture collecting suitable drains have been arranged. Section *JJ* shows the seal applied to the end of the door in the runway to prevent moisture from entering at that place. If, however, any water should collect there it would be drained off around the outside door track, as shown in section *AA*. The pressed steel shapes used throughout the construction are of No. 10 gage, open hearth steel. This door is also adaptable to refrigerator cars, special insulation being applied between the door boards.

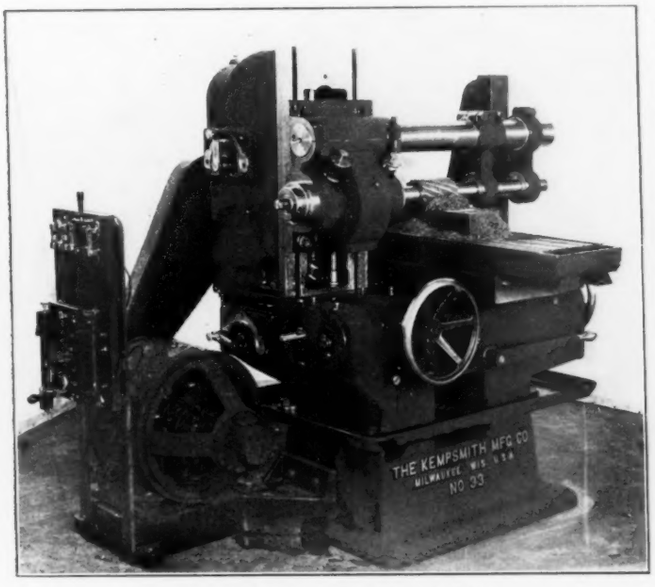
The small door to the left of the main door is for loading grain or other such commodities. It is also constructed so that it too may be closed tightly. The sections *AA*, *EE*, *FF* and *GG* show clearly the method of accomplishing this result. The door is locked by a malleable iron lock bar, as shown in the elevation drawing of the door. This bar is hinged to the door and swings vertically. It is provided with a tongue extending through the door that fits into a notch in the car side, so located that the door can only be locked wide open or closed. When opposite either notch the bar falls into mesh with a staple on the door, and is sealed by a lead rivet seal. The door cannot be opened without raising the lock bar, which will of necessity break the seal.

The claims of the builders for this door are as follows: It is so housed in the side of the car that it will be as substantial as any other part of the car; the steel door posts prevent bulging and make the operation of the door easy; the interlocking of the door with the door posts forms a moisture proof seal and prevents grain leakage; by insulating the door a practical and safe refrigerator door may be made; the door cannot be sprung open and entry must be made by breaking the seal; on account of its rigid construction the cost of maintenance will be materially reduced.

HEAVY MILLING MACHINE

A new type of milling machine has been recently placed on the market by the Kempsmith Manufacturing Company, Milwaukee, Wis. It is known as the Lincoln type and is especially designed for the manufacture of heavy duplicate parts. It is of the constant speed type, all changes of the spindle speed being effected through change and sliding gears. For each change of spindle speed there is a corresponding change of back gear ratio, which never falls below one to 2.15 and runs as high as one to 13 on the slowest speed, thus adapting the machine to taking the heavy cuts with high speed cutters. This feature combined with the large bearing surfaces of the saddle and table and the essentially rigid construction enables the machine to be used on a wide range of both light and heavy work.

The driving pulley is 15 in. in diameter and is flanged to carry a 4 in. double belt at a constant speed of 250 r. p. m. The arrangement also permits the application of a motor drive. The pulley is keyed to the main driving shaft, which runs in a pair of Standard roller bearings. This shaft is connected to the gear train through a clutch so



Heavy Motor Driven Milling Machine.

designed that it starts on friction and is later thrown into a positive three-tooth hardened steel clutch. Starting and stopping of the entire gear train, and consequently of the spindle, is controlled by either one of two levers from either side of the bed of the machine. To start the spindle the operator raises the starting lever, which when it is in its lowest position holds the clutch out. It is therefore impossible for jar or vibration to throw the clutch into engagement.

The power is transmitted to the spindle driving shaft by means of a train of spur gears mounted on short heavy shafts running in Standard roller bearings. As the changes in speed are secured solely through sliding gears it has been possible to make these gears with a large diameter and a wide face. The teeth have a coarse pitch with a 20 deg. pressure angle. The spindle is driven by a worm and gear. The worm is of hardened steel and is carried by a vertical shaft running in roller bearings, the end thrust being taken by ball bearings. The worm gear is made from a large bronze casting and is mounted between the spindle bearings. This construction is of considerable advantage since it reduces the torsional strain on the spindle. The worm and worm gear run in a totally enclosed case, containing an oil bath for the lubrication of the drive.

The spindle is made from a crucible steel forging, the bearings and inside taper hole being accurately ground. It runs in phosphor bronze bearings and is so arranged that the adjustments for wear may be made without disturbing the alinement. It is 18 in. long, and the diameter of the rear bearing is 2¾ in., the largest diameter of the front bearings is 4½ in. and the diameter of the nose is 4 in. The arbors fit in a tapered slot in the end of the spindle, being held in mesh by a "drawn in" rod, which gives a positive drive. The headstock into which the spindle boxes are fixed is provided with ample oil pockets and large glass oilers.

The head frame is of the box type construction, braced internally, with a face of ample dimensions, to which the headstock is firmly bolted by the four bolts. A heavy boss in the headstock fits accurately into a corresponding slot in the head frame, which preserves the vertical alinement. In addition to the spindle the headstock carries one end of the 4 in. overhanging solid steel arm, which is supported at its outer end by the outboard support. This overhanging arm is furnished with an intermediate arbor support, brass bushed, which can be used close up to the cutter. This arrangement gives positive alinement of the arbor and prevents the arbor being knocked out of line under a heavy cut. When not in use the over-arm may be pushed back out of the way.

Vertical adjustment of the headstock is made by means of a shaft projecting from the front of the bed below the head frame instead of at the top of the head frame as in former models. This shaft is provided with a dial graduated to thousandths of an inch, and also with hand wheel.

The table is provided with power longitudinal feed only and the changes in the rate of feed are secured in much the same manner as are the changes in spindle speed. The mechanism is simple and durable, with very little possibility of getting out of order, and is totally enclosed within the bed of the machine. There are no knuckle joints and the parts are readily accessible. The power feed is controlled by one lever at the front end of the bed, the feed at all times being engaged, released or reversed by means of this lever. The position of this lever always indicates the direction of feed. If in an upright position the feed is not engaged; if the lever is inclined to the right, the table travel will be to the right, and if the lever is inclined to the left, the table travel will be to the left. Six changes of table feed are provided ranging from ⅞ in. to 15 in. per minute. The quick return of the table is provided through a hand wheel, giving a table travel of 2 in. for each turn of the wheel.

The machine is so designed that a table much larger than that regularly furnished may be used without altering the saddle or bed, or impairing the efficiency of the machine. The table has three deep T-slots, ⅝ in. wide, and is provided with means for a return flow of the lubricating compound. The base of the machine has a large oil pan fully protecting the floor from any dripping of oil or other lubricant. For lubrication of the cutters every machine is regularly furnished with a geared oil pump running at a constant speed and driven by a Diamond roller chain.

The general specifications and dimensions of this machine other than those already mentioned are as follows:

Length of power longitudinal feed	36 in.
Working surface of table	42 in. x 13 in.
Length of table bearing on saddle	32 in.
Transverse adjustment of table	12 in.
Minimum and maximum distances of center line of spindle to top of table	2 in. to 12 in.
Distance from underside of overhanging arm to center line of spindle	5½ in.
Maximum distance from end of spindle to inner side of outboard support in position	25 in.
Spindle speeds	19 to 116 r. p. m.
Extreme floor space, 58 in. in direction of length of bed by 84 in. in direction of table travel.	
Height of top of table from floor	37 in.
Extreme height of machine	62 in.
Net weight	about 4,000 lbs.

POSTAL CAR LIGHTING FIXTURES

To meet the requirements of the exhaustive tests made on a Baltimore & Ohio postal car at Washington during the latter part of last year, which are described elsewhere in this issue, and the recent specifications for lighting postal cars issued by the post office department, the Safety Car Heating and Lighting Company, New York, has developed a new line of fixtures for this class of service.

Where the Pintsch lighting system is used, it was found desirable to use a type of metal reflector that would distribute the light properly on the letter cases, bag-racks and paper boxes without a wasteful use of the light on the ceiling and other parts of the car where it was not needed in the distribution of mail matter. Two types of aluminumized steel reflector units have been developed, one for letter case lighting and the other for bag-rack, paper box and storage lighting. Both of these reflector units are made to fit the standard Pintsch mantle lamp, and not only give the required illumination at all points in the car but, by a careful distribution of the light, economize on the gas consumption. The reflector unit shown in Fig. 1 is designed for use on Pintsch lamps in the center of the car to light the bag-racks and paper boxes as well as for general illumination in the car. The characteristic light distribution curve of this reflector is such as to make the labels at all points in the bag-rack and storage portions of the car very distinct.

The reflector unit shown in Fig. 2 is designed for use at the letter cases and its characteristic light distribution curve is such as to insure ample illumination on the horizontal reading plane as well as on all the letter case labels. The conditions of letter case lighting are such as to require careful study in the design of a reflector to meet the requirements, and without extreme care the lighting at some points on the letter case labels is very apt to fall below or above the specifications. This reflector meets these requirements in all cases and allows an ample margin for depreciation. With the standard postal car construction adopted by the post office department the mounting height of Pintsch mantles should be 7 ft. 7 in. from the center of the mantle to the floor of the car, and two different types of mantles are recommended for use with these reflectors.

For electric lighting the government has allowed a wide latitude in the use of lamps and reflectors, and the development of a universal type of lighting fixture has necessitated careful study of all conditions. With different spacing of the light units, any of the standard electric train lighting lamps may be successfully used. Considering the metal reflectors alone, it is necessary to provide a fixture that will give a variety of mounting heights considered in the relation of the top of the reflector to the base

Figs. 1 and 2—Bowl Units for Pintsch Mantle Lamps.

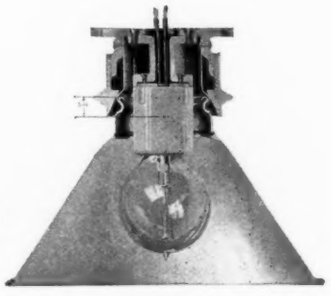


Fig. 3—Shade Holder and Adjustment for Electric Lamp.

Fig. 4—Universal Electric Lighting Fixture for Postal Car Letter Cases.

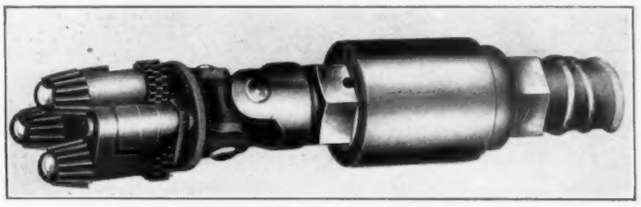
Fig. 5—Universal Electric Lighting Fixture for Bag Racks, Paper Boxes and Storage.

Fig. 6—Universal Electric Lighting Fixture for Letter Cases in Apartment Cars.

contact of the electric lamp. A reflector is designed to meet certain lighting requirements by providing a characteristic light distribution curve when the center of the light source is in a certain fixed relation to the reflector, and it is on account of the variable position of the filament in different types of electric lamps of different shapes and different wattages, that different heights of the base contact of the lamps in relation to the top of the reflector must be provided for in any universal lighting fixture. As in the case of the Pintsch mantle lamp, the light should be distributed where it is needed for the distribution of mail, and not wasted to light the ceilings of the car. It is claimed that the aluminumized and enameled steel reflectors are most satisfactory for this purpose, since they distribute the maximum light downward and in addition are practically free from the danger of breakage. Five types of steel reflectors have been selected for postal car lighting, of which that for letter case lighting is shown in Fig. 3. This is intended for all types of electric lamps used at the letter cases. To provide for the use of these different types of lamps and reflectors, six different positions of the base contacts of the lamps in relation to the top of the reflector must be available, and a shade or reflector holder has been developed on the principle of the safety shade holder, wherein a practically universal adaptation to any of these types of reflectors or lamps is obtained. The variable mounting height of the lamp filament in the reflector is taken care of by an extension member or socket support inside of the shade holder, while all the other parts of the shade holder are interchangeable for all conditions of postal car lighting. These shade holders are made to attach to the base and stem of a fixture designed to give the correct height from the center of the lamp filament to the floor of the car according to the requirements in the government specifications. The bases of these fixtures are made with either one or two outlets for either ½-in., ¾-in. or 1-in. conduit, and provide for an easy and accessible method of conduit wiring inside the car. This universal type of shade holder is also adapted, without change in its construction, to the many types of Crouse-Hinds condulets occasionally preferred by the engineer in installing his electric wiring. The feature of universally adapting a fixture for every requirement in postal car lighting should be of immense advantage in car lighting, since it provides for future developments in electric lamp manufacture or for a change in the standard types and sizes of lamps in use on the railway having these fixtures already installed.

REMOVING SCALE FROM ARCH TUBES

In some districts where waters that contain heavy scale forming salts are used, considerable difficulty is found in removing the incrustation from the interior of the arch tubes. Owing to the high temperature and the rapid evaporation from this heating surface, it is desirable, from the standpoint of safety as well as efficiency, to keep it as clean as possible. Because of the bends

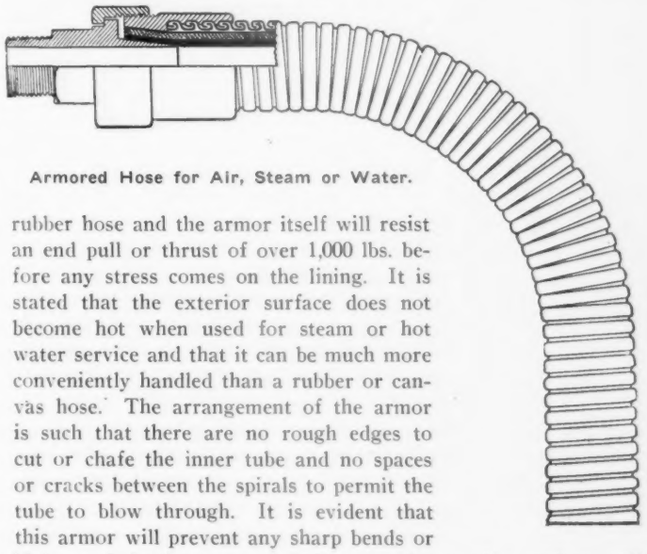


Device for Removing Scale from Arch Tubes.

in the pipe it is necessary to have a flexible arrangement for a cleaner and if the scale is very hard, the ordinary type of cleaner is not efficient. A flue cleaner that is especially suited for this work has been designed by the Lagonda Manufacturing Company, Springfield, Ohio, and is shown in the illustration. It is a turbine cleaner driven by an air or steam motor and has a very short head with a flexible tube connection so that it may be easily forced through the arch tube and will thoroughly clean it of all scale. It will be seen that the head contains revolving cutters and that it is connected to the tube by a universal joint. By its revolving motion the scale is scraped and chipped from the metal.

NON-KINKING AIR AND STEAM HOSE

An armored hose that will resist a crushing pressure of from 300 lbs. to 800 lbs. to each four turns of the spiral, depending on the size of the hose, and which is especially suited for shop air hose and hot water washing out hose in the roundhouse, is being made by the H. W. Johns-Manville Co., New York. It consists of a good grade of durable rubber hose protected against injury by a metal armor made in the form of a ribbon with crimped edges, forming, when wound, a continuous, interlocking flexible spiral, which is said to be practically pressure tight in itself. This spiral prevents any pulling strain coming on the



Armored Hose for Air, Steam or Water.

rubber hose and the armor itself will resist an end pull or thrust of over 1,000 lbs. before any stress comes on the lining. It is stated that the exterior surface does not become hot when used for steam or hot water service and that it can be much more conveniently handled than a rubber or canvas hose. The arrangement of the armor is such that there are no rough edges to cut or chafe the inner tube and no spaces or cracks between the spirals to permit the tube to blow through. It is evident that this armor will prevent any sharp bends or kinks and furthermore, that its smooth exterior surface will allow it to be handled with ease around the shop. The construction is such that when the inner tube does finally become worn out it can be renewed without the loss of the armored protection.

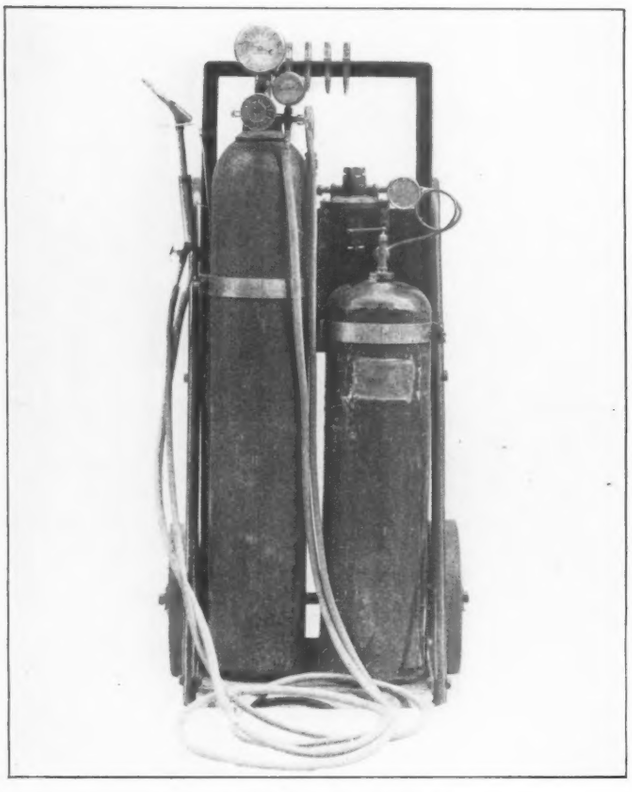
A special design of coupling of malleable iron or brass is furnished with each length of hose. This, as may seen in the illustration, consists of three pieces, one threaded and riveted to the armor, the second the threaded connection and the internal nipple fitting inside the inner tube, and the third a binding nut which holds them together and wedges the nipple tightly against the inner walls of the lining. It is recommended that when used for washout and other roundhouse work the armor should be made of copper instead of steel.

Brazilian Surveys Approved.—The president of the state of Sao Paulo, Brazil, has signed a decree approving the definite surveys of the first section of five miles of the line from Jaboticabal to Rio Pardo.

Cement in Russia.—The production of cement in Russia is developing rapidly, and new works are springing up and old works are extending their plants, notably around St. Petersburg and in the Baltic and South Russian districts. The result is that importers are feeling the effect of the home production very keenly. Although the price of the imported article has been lowered in order to combat Russian competition, this measure has so far been unsuccessful.—*The Engineer.*

PREST-O-WELDER

The Prest-O-Lite Company, Indianapolis, Ind., has recently placed on the market an oxy-acetylene portable welding outfit for general use in repair shops. Storage tanks of 100 cu. ft. capacity are furnished for each of the gases used. The whole equipment is mounted on a small steel truck as shown in the illustration which when fully assembled weighs 300 lbs. A temperature of 6,300 deg. F. may be obtained with this apparatus, which is considerably more than that required to melt any of the commercial metals. The acetylene is stored in a cold drawn seamless steel tank, and is dissolved in acetone in a porous filling inside the tank. It is fed through a regulating valve, which automatically maintains a constant flow of the gas. The oxygen is controlled by a regulating valve so that the heat of the flame may be maintained at the desired temperature. The welding points on the blowpipe are interchangeable,

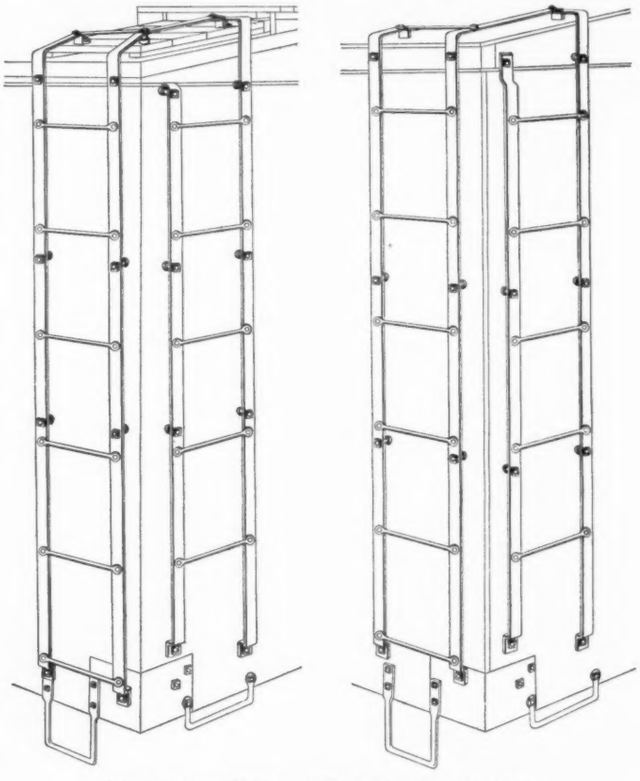


Oxy-Acetylene Welding Outfit.

and easily adapted for different sorts of materials and castings. The operation of this device is not difficult, and the ordinary workman may soon become proficient in all its uses. Cast iron, steel, brass, bronze or aluminum may be welded with it.

STEEL BOX CAR LADDER

An all-steel combination side and end ladder which includes roof grab irons, and is furnished in its complete form ready for bolting to the car, is being made by the Safety Steel Ladder Company, 810 Olive street, St. Louis, Mo. This ladder has rungs riveted to stiles made of bar steel and is held the proper distance from the car side by cast iron spools on the holding bolts. It requires no bolts in the roof and those in the sides are so spaced as to encounter solid members of the framing, eliminating all danger of bolts becoming loose or pulling through the siding. At the top, the stiles are bent over and down so that the ends rest on the roof or on the side running board in the case of metal roof cars. The end stile of the side ladder is carried over and bolted to the extending end of the inside stile of the end ladder and in this way it forms the roof grab iron for the latter. A rung riveted across the extending stiles forms the grab iron for the side ladder. In the case of cars with steel roofs, the side running board is formed separately and secured only to the ends of the ladder, this fastening being by means



Combination Side and End Box Car Ladders.

of three bolts which are sufficient to properly hold it in place and do not require any perforation of the roof sheet. With wooden roof cars the ends of the stiles simply rest on top of the roof and depend on the fastening through the plate for security. While the sill steps are not shown as being a part of the ladder, in the illustration, they can be so formed if desired.

Sulphur and Oxygen in Iron and Steel.—A paper on this subject, read before the Scotch Branch of the British Foundrymen's Association, by Dr. C. H. Desch, showed, according to *The Engineer*, that the presence of the sulphur in iron was most deleterious to the metal when it existed in the form of iron sulphide, which, having a lower melting point than the iron, was able to encase the crystals in a very brittle mesh-work. With the addition of manganese, however, and the formation of a double sulphide iron and manganese, this was much less harmful, owing to its higher melting point. This property entailed its separation from the metal before the iron solidified. In the case of steel too much sulphide produced brittleness. The effect of oxygen was to produce oxides in steel, it being very infrequently met with in iron. The inclusions found in burnt metal were said to be capable of largely increasing the tendency of the metal to corrode rapidly, and similar defects were apt to be set up by welding. Silicates were also formed, and either alone or in conjunction with the sulphides, produced weakness in the metals containing them.

Proposed New York-New Jersey Bridge.—The length of the proposed suspension bridge across the Hudson river at New York, would be 8,300 ft., and the estimated cost, $42,000,000.

NEWS DEPARTMENT

The Central Safety Committee of the Chicago & North Western has awarded the company's "Safety" banner for the best record of safety for the year 1912 to the East Iowa division.

The Atchison, Topeka & Santa Fe is planning to build a very complete reproduction of the Grand Canyon of Arizona to be exhibited at the Panama-Pacific Exposition in San Francisco. The reproduction of the canyon will occupy five acres.

Officers of the Grand Trunk say that the increase in wages paid for organized labor for 1912 over 1911 amounts to $750,000, and that the increases for other classes of employees will amount to very nearly an equal amount; bringing the total wage increases for the year up to nearly $1,500,000.

The New York, New Haven & Hartford announces that since Mr. Mellen made his ten-thousand-dollar offer, published a few months ago, 1,574 automatic train stops have been presented to it; and that two of the devices submitted are going to be tried. The names of these two are not given, being withheld, evidently, for the purpose of breaking the news gently to the friends of the other 1,572.

The Rock Island Lines have purchased a roll of moving picture films on fuel economy from the International Railway Fuel Association, which is being used in connection with lectures to the enginemen given by H. Clewer, superintendent of locomotive operation, at the principal points on the system. Bound proceedings of the 1912 convention of this association have also been furnished the master mechanics, road foremen of equipment and the supervisors of locomotive operation; and copies of D. C. Buell's paper on Fuel Economy, presented before the Fuel Association last year, have been distributed among the engine crews. The results obtained by Mr. Clewer and his staff of supervisors have been very encouraging.

FIREMEN'S ARBITRATION PROCEEDINGS

The arbitration of the firemen's wage controversy under the Erdman Act commenced at the Waldorf-Astoria hotel, New York, Monday, March 10. Under the terms of the act, a decision must be rendered within 30 days unless both sides agree to an extension of time. As the evidence will not be submitted in sufficient time to permit a decision being reached in the time allowed, the railroads and firemen agreed to an extension on March 26.

MEETINGS AND CONVENTIONS

General Foremen's Association.—The next convention of the International Railway General Foremen's Association will be held July 15-18, 1913, and not July 22-25, as announced in the March issue of the *American Engineer*.

Canadian Railway Club.—Following the examples of several other clubs during the past year the subject of safety was discussed at the March meeting. The paper was by N. S. Dunlop, claims adjuster, Eastern Lines, Canadian Pacific. It briefly pointed out the importance of the "Safety First" movement and was largely devoted to reviewing the causes of avoidable accidents.

Central Railway Club.—At the March meeting the report of the committee on revision of the M. C. B. rules of interchange was presented and discussed. Various recommendations were made for minor changes in a large number of the rules. These will be referred to a joint committee of all railway clubs, which will then report to the Arbitration Committee of the Master Car Builders' Association. In addition to this report, W. S. Sitterly, general car inspector of the Pennsylvania Railroad, gave a talk on the proper preparation of repair and defect cards.

American Society of Mechanical Engineers.—Arrangements have been perfected for the New York meeting which has been planned by the Railway Committee for the evening of April 8, when the subject of "Steel Passenger Cars" will be discussed. The members of the New York Railroad Club and of the Railway Club of Pittsburgh have been invited to join with the society on that evening. To allow for a thorough discussion the meeting will be opened at 8 o'clock sharp. The following engineers have consented to prepare ten minute discussions on the subjects which have been assigned to them, and about which they are particularly well posted. Several of these have already been received and are being printed for advance distribution. The following subjects will be considered: Introduction to General Discussion of Steel Passenger Cars, H. H. Vaughan, assistant to the vice-president, Canadian Pacific; Problems of Steel Car Design, W. F. Kiesel, Jr., assistant mechanical engineer, Pennsylvania Railroad; Steel Underframes, J. McE. Ames, American Car & Foundry Company; Roof Structure for Steel Cars, C. A. Seley, mechanical engineer, Rock Island Lines; Suspension of Steel Cars, E. W. Summers, president, Summers Steel Car Company; Trucks for Steel Passenger Cars, J. A. Pilcher, mechanical engineer, Norfolk & Western; Interior Finish for Steel Passenger Cars, Felix Koch, assistant mechanical engineer, Pressed Steel Car Company; Painting of Steel Passenger Cars, C. D. Young, engineer of tests, Pennsylvania Railroad; Provision for Electric Lighting in Steel Passenger Cars, H. A. Currie, assistant electrical engineer, New York Central & Hudson River; Provision for Electrical Equipment on Steel Motor Cars, F. W. Butt, assistant engineer, New York Central & Hudson River; Air Brakes for Heavy Steel Passenger Cars, A. L. Humphreys, vice-president and general manager, Westinghouse Air Brake Company; Cast Steel Double Body Bolster, Platform and Frames for Steel Cars, C. T. Westlake, chief mechanical engineer, Commonweaith Steel Company; Draft Gears for Steel Passenger Cars, S. P. Bush, Buckeye Steel Castings Company; Special Ends for Steel Passenger Cars, H. M. Estabrook, president, Barney & Smith Car Company.

RAILROAD CLUB MEETINGS

Club.	Next Meeting.	Title of Paper.	Author.	Secretary.	Address.
Canadian	April 8	System as Applied to Shop Repairs of Locomotives	A. H. Kendall	Jas. Powell	Room 13, Windsor Hotel, Montreal.
Central	May 9	The Signal Department	B. H. Mann	H. D. Vought	95 Liberty St., New York.
New England	April 8	Modern Air Brake Equipment for Steam Roads	Charles V. Joys	Wm. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	April 18	German Railways	Prof. Wm. Cunningham	H. D. Vought	95 Liberty St., New York.
Pittsburgh	April 25	Operating Conditions and the Air Brake	W. V. Turner	J. B. Anderson	Union Station, Pittsburgh, Pa.
Richmond	April 14	A Trip Through the World's School House	J. F. Bartlett	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	April 11	The Package Car	J. R. Cavanagh	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	April 15	Specifications	Bruce V. Crandall	Jos. W. Taylor	390 Old Colony Bldg., Chicago.

New York Railroad Club.—The annual electrical night was held on the evening of Friday, March 21; following the usual custom there was no paper prepared, but the meeting was addressed by several electrical experts on different phases of electricity as employed for heavy railroad traction. William McClellan reported, as chairman of the committee on this subject for the club, and his remarks were practically the keynote for the expression of the later speakers. He pointed out that the electrical engineers have greatly modified their expectations of a number of years ago and have come to the realization that there will be no general and complete electrification of steam railways for many years to come. This is due largely to financial conditions. At present there is no new steam railroad electrification under way, although there have been several material extensions to the systems already in use. Within a short time there will be a considerable amount of new electrification undertaken. The two principal projects that have been settled are 204 miles on the Denver & Rio Grande, and 440 miles on the Chicago, Milwaukee & St. Paul. It was pointed out, however, that in both of these cases electrification was in mountain districts where power could be obtained very cheap. Mr. McClellan stated that there is no barrier to extensive electrification so far as the choice of the system to be used or the mechanical and electrical engineering features are concerned. It is assured that electric locomotives, transmission lines, power houses, etc., can be built to satisfy any existing condition. It appeared to make comparatively little difference in a general way as to which kind of current is employed. As an example of the effect of the financial features on the subject, the investigation of the Boston & Albany on electrification in the suburban district of Boston, was given, where it was conclusively shown that with the same rates of fares as at present and with a normal increase in traffic there would be a loss of $500,000 a year in this district if the lines were to be electrified. E. B. Katte, chief engineer of electric traction of the New York Central & Hudson River, reported that the extension of the electric division to Croton, N. Y., was proceeding rapidly and that the suburban motor car trains were now being operated to that terminal. Within the next year all passenger trains will be operated electrically as far as Harmon, N. Y. The reliability of the electrical equipment was mentioned, and it was stated that locomotives operate on an average of 4,500 miles for each electrical attention, and the motor cars run 11,000 miles for each electrical attention. The cost of repairs to locomotives was reported as 3⅓ cents a locomotive mile, and the motor cars as 1.8 cents a car mile. Other speakers included Frank J. Sprague, J. Mailleux and Frank Hedley.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

Air Brake Association.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 6-9, 1913, St. Louis, Mo.

American Railway Master Mechanics' Assoc.—J. W. Taylor, Old Colony building, Chicago. Convention, June 11-13, 1913, Atlantic City, N. J.

American Railway Tool Foremen's Association.—A. R. Davis, Central of Georgia, Macon, Ga. Convention, July 22-25, 1913, Chicago, Ill.

American Society for Testing Materials.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Annual convention, June, 1913.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual meeting, December 3-6, Engineering Societies' Building, New York. Railroad session, Thursday morning, December 5.

Car Foremen's Association of Chicago.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, Chicago.

International Railway Fuel Association.—C. G. Hall, McCormick building, Chicago. Convention, May, 1913, Chicago.

International Railway General Foremen's Association.—William Hall, 829 W. Broadway, Winona, Minn. Convention, July 15-18, 1913, Chicago, Ill.

International Railroad Master Blacksmith's Association.—A. L. Woodworth, Lima, Ohio. Convention, August 18, 1913, Richmond, Va.

Master Boiler Makers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention, May 26-29, 1913, Chicago.

Master Car Builders' Association.—J. W. Taylor, Old Colony building, Chicago. Convention, June 16-18, 1913, Atlantic City, N. J.

Master Car and Locomotive Painters' Assoc. of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass. Convention, Sept 9-12, 1913, Ottawa, Can.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 19-21, 1913, Auditorium Hotel, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

L. A. Richardson, master mechanic of the Rock Island Lines at Chicago, has been appointed mechanical superintendent of the third district at El Reno, Okla., succeeding C. M. Taylor, transferred.

C. M. Taylor, mechanical superintendent of the third district of the Rock Island Lines, at El Reno, Okla., has been appointed mechanical superintendent of the second district at Topeka, Kan., succeeding S. W. Mullinix, transferred.

G. W. Seidel, superintendent of shops of the Chicago, Rock Island & Pacific at Silvis, Ill., has been appointed superintendent of motive power of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., succeeding C. E. Gossett, general master mechanic, deceased.

George McCormick, whose appointment as assistant general manager (mechanical) of the Sunset-Central Lines of the Southern Pacific, with headquarters at Houston, Tex., was announced in the March issue of the *American Engineer,* was born July 15, 1872, at Columbus, Colorado county, Tex. He was graduated from the Agricultural and Mechanical College at Bryan, Tex., with the degree of Mechanical Engineer, in 1891. He began railway work in 1891 as apprentice in the shops of the Galveston, Harrisburg & San Antonio at Houston, Tex. In a short time he was transferred to San Antonio, Tex., as draftsman, returning to Houston in 1895 as chief draftsman. He was appointed mechanical engineer in 1900, where he remained until December 20, 1911, when he went to El Paso, Tex., as assistant superintendent of the El Paso division. He held the latter position until his appointment on February 17 as assistant general manager (mechanical) of all the Sunset-Central Lines.

George McCormick.

Nicholas Luke Smithan, whose appointment as assistant superintendent of motive power of the Missouri, Kansas & Texas Railway of Texas, with headquarters at Denison, Tex., was announced in the March issue of the *American Engineer,* was born in December, 1862, at Cornwall, England. He was educated in the public schools of Hazleton, Pa., and began railway work in 1877 as boilermaker apprentice with the Lehigh Valley. In the latter part of 1881 he went with the Colorado Iron Works at Denver, Colo., as boilermaker, remaining there a year, and then until the latter part of 1883 was with the Denver & South Park Railway as boilermaker. From that time until December, 1884, he was employed by the Denver & Rio Grande in a similar capacity, leaving to go to the Houston & Texas Central at Houston, Tex. In March, 1885, he was transferred to Walnut Springs, Tex., as general foreman in charge of boiler work.

He was made general foreman of the Texas Midland at Terrell, Tex., in 1893, and two years later was promoted to master mechanic, resigning in January, 1901, to become master mechanic of the Texas Central at Walnut Springs, Tex. He then returned to the Texas Midland as master mechanic, and nine months later again entered the service of the Texas Central as master mechanic, which position he held until his recent appointment as assistant superintendent of motive power.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

T. S. UNDERWOOD, general foreman of the St. Louis & San Francisco, at Monett, Mo., has been appointed master mechanic, at Paris, Tex.

H. W. CULVER has been appointed road foreman of engines of the Canadian Northern, at Winnipeg, Man., succeeding J. A. Carroll, transferred.

J. C. RHODES, road foreman of equipment at Trenton, Mo., has been appointed master mechanic of the Dakota division of the Chicago, Rock Island & Pacific, with headquarters at Estherville, Ia.

N. C. BETTENBERG, locomotive foreman of the Great Northern at St. Paul, Minn., has been appointed master mechanic, with headquarters at Crookston, Minn., succeeding J. W. Smith, transferred to Duluth, Minn.

G. W. WHITELEY, district master mechanic of the Canadian Pacific, at Moose Jaw, Sask., has been appointed master mechanic of the Alberta division, with headquarters at Calgary, Alta., succeeding A. T. Shortt, promoted.

E. J. HARRIS, master mechanic of the Kansas City Terminal division at Armourdale, Kan., has been appointed master mechanic of the Missouri division of the Chicago, Rock Island & Pacific, with headquarters at Trenton, Mo.

R. L. STEWART, master mechanic of the Missouri division of the Chicago, Rock Island & Pacific at Trenton, Mo., has been appointed master mechanic of the Chicago Terminal and Illinois divisions, with headquarters at Chicago, in place of L. A. Richardson, promoted.

R. Q. PRENDERGAST, whose appoinment as master mechanic of the Indianapolis division of the Cincinnati, Hamilton & Dayton, with headquarters at Indianapolis, Ind., was announced in the March issue of the *American Engineer*, began railway work as a machinist apprentice with the Baltimore & Ohio at Benwood, W. Va. After completing his apprenticeship he was made foreman at Cameron, W. Va., and subsequently was transferred to several of the large shops on the Baltimore & Ohio system, including the position of erecting shop foreman of the Mt. Clare shops. He left the Baltimore & Ohio to go to the Cumberland Valley at Chambersburg, Pa., and later became general foreman of the Delaware & Hudson at Carbondale, Pa. He resigned about five years ago to accept the position of master mechanic of the Denver & Rio Grande, at Pueblo, Colo., which he held until his recent appointment.

CAR DEPARTMENT

R. J. BANNON has been appointed car foreman of the Louisiana division of the Chicago, Rock Island & Pacific, at El Dorado, Ark.

A. R. JAY has been appointed foreman of the heavy repair yard of the Pennsylvania Lines West of Pittsburgh, at Conway, Pa., succeeding Charles Buss, transferred.

CHARLES BUSS, foreman of the heavy repair yard of the Pennsylvania Lines West of Pittsburgh, at Conway, Pa., has been transferred to Allegheny as foreman of freight car builders.

SHOP AND ENGINE HOUSE

C. BAKER has been appointed locomotive foreman of the Canadian Pacific at Outlook, Sask.

ROBERT F. BRUMBACH has been appointed foreman of the Houston & Texas Central at Hearne, Tex.

A. E. BENNETT has been appointed locomotive foreman of the Canadian Pacific at Grand Forks, B. C.

THOMAS GORDON has been appointed roundhouse foreman of the Rock Island Lines at Valley Junction, Ia.

C. W. WARCUP has been appointed night roundhouse foreman of the Rock Island Lines, at Rock Island, Ill.

L. FENSTUMAKER has been appointed foreman of the boiler shop of the Erie railroad, at Galion, Ohio, succeeding John Meyers.

M. L. CRAWFORD, general foreman of the St. Louis & San Francisco, at Fort Smith, Ark., has been transferred to Monett, Mo.

W. G. REID has been appointed general foreman of the Globe shops of the Arizona Eastern, succeeding Max Fiedler, promoted.

C. J. DRURY has been appointed general foreman of the St. Louis & San Francisco at Fort Smith, Ark., succeeding M. L. Crawford, transferred.

F. CLARK has been appointed locomotive foreman of the Canadian Northern, at Radville, Sask., succeeding R. H. Mann, assigned to other duties.

H. D. VAN VALIN has been appointed foreman of the locomotive department of the Chicago, Rock Island & Pacific, at Forty-seventh street, Chicago, Ill.

A. T. SHORTT, master mechanic of the Alberta division of the Canadian Pacific, at Calgary, Alta., has been appointed superintendent of the Ogden shops, Calgary.

H. B. MINNICK has been appointed assistant machine shop foreman of the Lake Shore & Michigan Southern, at Collinwood, Ohio, succeeding W. C. Cruwell, promoted.

W. C. CRUWELL, assistant machine shop foreman of the Lake Shore & Michigan Southern, at Collinwood, Ohio, has been appointed machine shop foreman, succeeding I. C. Newmarch, promoted.

S. W. MULLINIX, mechanical superintendent of the second district of the Rock Island Lines, at Topeka, Kan., has been appointed superintendent of shops at Silvis, Ill., succeeding G. W. Seidel, resigned.

R. H. MONTGOMERY, general foreman of the locomotive shops of the Lake Shore & Michigan Southern, at Collinwood, Ohio, has been appointed superintendent of shops, succeeding B. F. Kuhn, promoted.

I. C. NEWMARCH, machine shop foreman of the Lake Shore & Michigan Southern, at Collinwood, Ohio, has been appointed general foreman of the locomotive shops, succeeding R. H. Montgomery, promoted.

PURCHASING AND STOREKEEPING

A. F. MCCOOL, chief clerk to the purchasing agent of the St. Louis & San Francisco at St. Louis, Mo., has been appointed assistant purchasing agent of the south Texas and Louisiana lines, with headquarters at Houston, Tex., succeeding J. L. White, resigned.

E. B. DAILEY, assistant mechanical engineer of the Union Pacific at Omaha, Neb., and H. B. Henry, who has been in the office of the director of maintenance and operation of the Harriman Lines at New York, have been appointed assistants to the director of purchases of the Southern Pacific Company, both with offices at New York.

New Shops

Canadian Pacific.—A concrete machine shop will be built at McAdam Junction, N. B.

Louisville & Nashville.—Plans are being prepared for repair shops at Lexington, Ky.

Gulf, Colorado & Santa Fe.—It is planned to enlarge the capacity of the roundhouse at Slaton, Tex.

Oregon Short Line.—This company is said to be planning the erection of a large addition to its shops at Ogden, Utah.

Duluth, South Shore & Atlantic.—This company is preparing to build a new 15-stall roundhouse at Marquette, Mich.

Grand Trunk.—It is reported that a new roundhouse and shops will be erected at Hamilton, Ont. This item is not confirmed.

Chicago, Rock Island & Pacific.—This company has announced that appropriations have been made for the enlargement of its shops at Fairbury, Neb.

Chicago, Rock Island & Pacific.—This company will spend $500,000 this year, it is said, building new terminals, shops and roundhouses at St. Paul, Minn.

Missouri, Oklahoma & Gulf.—This company has let contracts for the erection of new shops and other improvements at Muskogee, Okla., to cost about $250,000.

Missouri & North Arkansas.—This company will construct general shops and terminals at Harrison, Ark., at a cost of $125,000, and a roundhouse at Heber Springs, Ark.

Lake Shore & Michigan Southern.—Land has been purchased at Ashtabula, Ohio, on which repair shops will be built for steel cars. The plant and land will cost about $1,000,000.

Texas & New Orleans.—Work has been started on the construction of a new blacksmith and boiler shop building of reinforced concrete construction, 314 ft. x 120 ft., at Houston, Tex.

Buffalo, Rochester & Pittsburgh.—Changes are to be made at the shops at Du Bois, Pa., which will double their present capacity. A building, 35 ft. x 70 ft., for the reclaiming of scrap, will be erected and a steel car shop, 192 ft. x 400 ft. is under consideration.

Fuel Oil in Roumania.—A few locomotives were converted into oil burners as long ago as 1887. In 1911, out of a total of 595 locomotives, 499 used oil for fuel. About five-eighths of the fuel is petroleum, one-eighth is coal from Cardiff and Westphalia, more than a seventh lignite, and one-tenth wood.—*The Engineer.*

Argentine Railway Concessions.—The Argentine Director General of Railways is drafting a bill dealing with the conditions to be fulfilled by applicants for railway concessions. The object is to put a stop to acquiring concessions which will never be carried out and are obtained for speculative purposes, either by endeavoring to sell to an existing railway company whose zone has been invaded or for land speculation.

Law Against Stealing from Cars.—One of the measures recently passed by Congress makes it a felony to break the seal of a railroad car containing interstate or foreign shipments of freight, express, or baggage, or to enter such a car with intent to steal, or to steal, conceal, or by fraud or deception obtain from any railroad car, station house, depot or platform any goods or chattels which are part of an interstate or foreign shipment of freight, express, or baggage.

Supply Trade Notes

Edgar N. Easton is now associated with the railroad sales department of Joseph T. Ryerson & Son, with headquarters at New Haven, Conn.

R. C. Fraser, representative of the Buffalo Brake Beam Company, has been made vice-president of the company, with headquarters at 30 Pine street, New York.

C. J. Morrison has resigned his position with Suffern & Son, and with others has organized Froggatt, Morrison & Company, 149 Broadway, New York, efficiency engineers.

The Kerr Turbine Company, Wellsville, N. Y., manufacturers of the Economy steam turbine, have appointed F. A. Mazzur & Co., 141 Milk street, Boston, as their New England representatives.

John H. Craigie, formerly with the mechanical department of the Boston & Maine, is now associated with the railroad sales department of Joseph T. Ryerson & Son, with headquarters at Boston, Mass.

Abram Lucas, general foreman of the locomotive department of the Chicago, Milwaukee & St. Paul, with office at Milwaukee, Wis., has resigned to go to the Jacobs-Shupert U. S. Fire Box Company, Coatesville, Pa., with office at Chicago.

H. F. Ball has been elected president of the Economy Devices Corporation, 30 Church street, New York, which has taken over the business of the Radial Buffer Company, the the latter company having been dissolved. Among the devices which will be marketed by the new company is the radial engine and tender buffer which was described in the September, 1912, *American Engineer*, page 489. Mr. Ball entered the service of the Pennsylvania Railroad as an apprentice at Altoona, Pa., in 1884. Four years later he entered the drafting room at Altoona, and in 1890 was appointed chief draftsman of the car department of the Lake Shore & Michigan Southern. Two years later he was placed in charge of the car shops at Cleveland, as general foreman, and in 1894 was appointed general car inspector. Five years later he was made mechanical engineer of the Lake Shore, which position he held until his promotion to the position of superintendent of motive power in February, 1902. In 1906 he left the Lake Shore to accept the vice-presidency of the American Locomotive Automobile Company; a few months later his jurisdiction was extended over the American Locomotive Company, as vice-president of engineering. In December, 1912, he left the American Locomotive Company to open an office as a special consulting engineer. Mr. Ball was president of the Central Railway Club in 1900, and of the American Railway Master Mechanics Association in 1905-6.

H. F. Ball.

The Pedrick Tool & Machine Company, 3640 N. Lawrence street, Philadelphia, Pa., has been formed by A. D. Pedrick and H. A. Pedrick, who have recently resigned from the firm of H. B. Underwood & Co. The new company will make and

sell the Pedrick portable tools, including cylinder boring bars, cylinder and dome facers, crank pin turning machines, driving box planer tools, pipe benders, milling machines, radius planing attachments, and valve seat rotary planers. D. W. Pedrick has also resigned from H. B. Underwood & Co.

Burton W. Mudge & Co., Chicago, have been made agents for the Industrial Works, Bay City, Mich. This company will handle the products of the Industrial Works, including wrecking, locomotive and freight station cranes, pile drivers, transfer tables and grab buckets.

H. B. Underwood & Company, Philadelphia, Pa., have announced a change in partnership, Morris G. Condon having purchased his partners' interests. There are now associated with him in the company David C. Hitchner, Hiram D. Griffith and Charles O. Ralph.

The Meeker Grip Nut Company, 1170 Broadway, New York, has just been formed to make and sell Meeker grip nuts. The officers of the company are as follows: President, Fred J. Lancaster; vice-president, Walter Schulze; and secretary and treasurer, Samuel G. Meeker. George Owens has been made manager of the sales department.

GEORGE M. BASFORD

George M. Basford, assistant to the president of the American Locomotive Company, has resigned to accept a position as chief engineer of the railroad department of Joseph T. Ryerson & Son, Chicago, with headquarters at 30 Church street, New York. Mr. Basford was graduated from the Massachusetts Institute of Technology in 1889. Directly afterwards he entered the Charlestown shops of the Boston & Maine, later going to the Chicago, Burlington & Quincy as a draftsman at Aurora, Ill. From there he went to Omaha, Neb., to take a position in the motive power department of the Union Pacific, and was also for some time connected with the test department of that road. Leaving the motive power department service he became signal engineer of the Chicago, Milwaukee & St. Paul, after which he was superintendent of construction of the Johnson Railway Signal Company, was for a short time with the Union Switch & Signal Company, and was signal engineer of the Hall Signal Company. In 1895 he left signal work to become mechanical department editor of the *Railway & Engineering Review*, and in 1897 was made editor of the *American Engineer & Railroad Journal*. In September, 1905, he accepted a position with the American Locomotive Company as assistant to the president, which position he now leaves to enter the service of the Ryerson company.

George M. Basford.

For a number of years, 1897 to 1905, Mr. Basford was editor of this journal, and it is with great pleasure that we reproduce the following account of his past work, which appeared in the *Railway Age Gazette* of March 14, 1913:

"Mr. Basford is the father of the Railway Signal Association. Shortly after taking up editorial work in Chicago he called together a number of those interested in signaling, to consider the formation of a Railway Signaling Club, which later developed into the national association. For the first two years, 1895 and 1896, he was secretary-treasurer of the organization and a most active factor in its upbuilding.

"Few men associated with the railway interests can number so many friends—real friends—as can Mr. Basford. And this he richly deserves, for he has been untiring in aiding others, either with advice or by helping them to better their condition. He has an unerring engineering instinct, which enables him to discard those things which are superficial and quickly get at the heart of a problem. It was this instinct, coupled with an extensive experience, and with his splendid character which made him such a power as an editor—for many years the *American Engineer* was informally designated as "Basford's paper," and still is by some, although it is seven and a half years since he left it. And when we recall that for a considerable part of his eight or nine years' work on that paper he had no editorial assistant, no stenographer, and that the office was not equipped with a telephone, we marvel at the powerful influence he was able to exert through its pages in securing a more fitting recognition of the real importance of the motive power department in the railway organization.

"In the fall of 1903 Mr. Basford was in receipt of a signal honor, the like of which has never been conferred upon a mar in the railway or railway supply field before or since. In a quiet way fifty-eight of the railway and railway supply men who were known to be close personal friends of Mr. Basford's, joined together and presented him with a volume of personal letters expressing their appreciation of him, and accompanied by a substantial check to defray the expenses of a trip abroad. The following is taken from an informal presentation address made by W. S. Morris, who was then with the Erie Railroad: 'The gentlemen around you are not only your personal friends, but they are here to represent a host of admirers, whom you can with pride claim also as friends. We are here to tender not only our admiration of the efforts God has infused within your character and ambition, but to thank you in behalf of the many who have been instructed and benefited by your industry and faithfulness to the science through which we all claim kin to one another. In all probabilities this is the first time in the history of this generation, at least, that one has been so honored by the mechanical fraternity of this country, and we assure you it is extended with every thought of true manliness and absolute worthiness on the part of him to whom these words are addressed. To be plain, Mr. Basford, your friends feel that you have well earned some token of recognition at their hands, and we beg that you will accept this volume, which contains the sentiment, individually, of those whom the gentlemen here present have the honor to represent, and this, which is intended to give you a much needed rest in the way of an extended trip to Europe; and, also, although perhaps selfishly, we hope you may find some time to tell us of your travels and give some hints of interest which may be found on the other side.'

"Mr. Basford is widely known because of the impetus he gave to the development of the movement for educating and training apprentices and workmen, for he had a keen realization of the fact that the most vital problem confronting the railways is that of *men*. In 1905, after he had given several years of careful study to the situation he presented a paper before the Railway Master Mechanics' Association on 'The Technical Education of Railroad Employees—The Men of the Future.' The principles which he outlined in this paper attracted wide attention, not only in the railroad field but in the industrial world as well, and were taken as the foundation of such modern apprenticeship systems as those on the New York Central Lines and the Atchison, Topeka & Santa Fe. And it may be said at this date, almost eight years after the presentation of the paper, that apprenticeship systems on the railways have proved successful in so far as they have followed the fundamental principles laid down in Mr. Basford's address. The

preparation of this paper might well be studied by young men who are ambitious to make their efforts felt in the railway field, and it affords a marked contrast to some of the papers and reports which are often presented before railway clubs and technical associations. It was the result of years of study of conditions on the railroads in this country and a practical experience in mechanical department work. Foreign methods had been carefully looked over on his trip abroad and then the whole scheme was carefully planned and outlined. The paper was then drafted roughly and was rewritten and rewritten until every sentence was carefully rounded out and every superfluous word removed, so that the thought was clear and forceful throughout. It was then submitted for criticism to a number of leading railway officers and industrial managers, and their comments were carefully considered in its revision, although it may truthfully be said that such revision as was made was very slight indeed. And dominating it all was a broad spirit of fellowship for his fellow man, which is so characteristic of Mr. Basford. It is little wonder that it marked the real corner-stone of railway apprenticeship education in this country, and it is to be regretted that more railroads have not adopted and lived up to its spirit.

"It would be hard to comment intelligently upon Mr. Basford's work as assistant to the president of the American Locomotive Company, for necessarily a large part of it was in special assignments and would be very little known outside of the officers of the company. Of one definite duty, however, which was assigned to him during the entire time of his association with that company we may speak authoritatively, and that is the matter of publicity. Many years ago when an editor Mr. Basford said that the day would come when the advertising pages of the railway technical papers would be read first, for the advertiser when he awakened to the real possibilities of advertising would have a distinct advantage over the editors, because he could display his data to so much better advantage, not being tied down to the standards of typography that the editor must observe; and to Mr. Basford belongs the honor of being the first to consistently make such use of the advertising pages as to secure the close attention of railway officers and indeed to make many of them tear out and preserve the ads. of his company, so valuable was the information presented therein. Most of our readers are familiar with this work. The campaign was carefully planned and developed, just as the editor of a paper would plan and develop his editorial policy, and was based upon supplying to the railways information which they greatly needed, and presented in such a way as to make railway men read it and feel its forcefulness. This feature, which was quickly observed by other companies, is being adopted by many of them and has brought about a new era of publicity in the railway field.

"During the winter of 1908-9 while the Railway Business Association was in its early stages of development an arrangement was made with the American Locomotive Company whereby Mr. Basford gave part of his time to the work of that association. That his efforts were fruitful is indicated by the following paragraph in a letter written by George A. Post, president of the association (a copy of which Mr. Post has kindly furnished us) when it became necessary for Mr. Basford to withdraw from active personal participation in the work, because of the pressing demands of his duties with the American Locomotive Company: 'Whatever may be the ultimate verdict as to the usefulness and necessity for this association, there can be but one judgment of what you did in an emergent situation, when you brought to it the vigor of your push and industry, the good cheer of your persuasive personality and the impetus of your alert and fecund mentality. To work with you has been an unalloyed pleasure; to confer with you has been to draw inspiration, and to part with your services is a distinct loss which I shall constantly deplore. If, in carrying the burdens developing upon me in this work, no other dividend of the like were mine than that afforded by the opportunity to feel that I am heart-hitched to George Basford thereby, I shall always feel that the Railway Business Association did a splendid thing for me.'

"Mr. Basford's hobby has always been the locomotive, and his efforts in its development were recently summed up by one of his friends as follows: 'He has persistently striven to impress upon every one connected with the work, both through his paper and through his personal contact, with a possibility of improving locomotive practice by rational and progressive engineering methods, and is largely responsible for the improvement that has taken place not only in the general design of the locomotive, but also in the improvement in the construction of its various parts which has so largely increased its efficiency and economy in operation. The care which Mr. Basford took in carrying out the experiments on locomotive front ends and nozzles, which led to the completion of these experiments by the Master Mechanics' Association, is only one example of his endeavors to place the design of the locomotive on a thoroughly sound foundation. The success of these experiments was no doubt a strong factor in the adoption of the locomotive testing plant, and the knowledge we now possess as to what engines are actually doing, and what results can be obtained from them. Not only in locomotive design, but in shop practice and road work generally, Mr. Basford has energetically encouraged his friends and acquaintances, including all the important mechanical men in the country, to continually improve their results. I do not think you will make any mistake in crediting him with a large share of the development in the last fifteen years.'

"Possibly this sketch might well be closed with the following brief summation of his personality by another one of his friends: 'He has a clear conception of mechanical and operating needs. A way of keeping himself in the background and furnishing his numerous friends with good ideas from his generous store. Taking great pleasure in the advancement of young men and helpful to all with whom he comes in contact.'"

The Equipment Improvement Company, 30 Church street, New York, has been organized to handle the Markel devices for locomotives and the Perfection door stop. The directors of the company are as follows: Alexander Turner, Bronze Metal Company, New York; R. H. Weatherly, Pilliod Company, New York; Le Grand Parish, American Arch Company, New York; F. H. Clark, Watson-Stillman Company, Ampere, N. J.; T. H. Hopkirk, American Steel Foundries, New York; T. Rumney, formerly assistant second vice-president of the Chicago, Rock Island & Pacific; and P. H. Ferguson, Pittsburgh Steel Products Company, Pittsburgh, Pa. The officers are as follows: President, F. H. Clark; vice-president, W. E. Weatherly; and secretary-treasurer, R. H. Weatherly. In the near future the company will handle other devices in addition to those mentioned above.

W. H. Foster has resigned as master mechanic of the Hudson division of the New York Central & Hudson River, to accept a position with the Ashton Valve Company, as representative in the railroad department, with headquarters in New York. Mr. Foster was born June 29, 1873, and entered railway service in June, 1889. After considerable experience in shop work, and as fireman and locomotive engineer, he became air brake instructor for the American Magazine Company, and later became connected in the same capacity with the International Correspondence Schools. In February, 1902, he was appointed supervisor of air brakes for the New York Central, and in 1907 his jurisdiction was extended over the Boston & Albany, which placed him in charge of air brake instruction on all divisions of the New York Central lines east of Buffalo. On January 1, 1908, he was promoted to master mechanic.